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Incentive approach behaviour as a function of water deprivation, sucrose concentration and mode of forced choice presentation in the albino rat.

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INCENTIVE APPROACH BEHAVIOUR AS A FUNCTION OF WATER DEPRIVATION, SUCROSE CONCENTRATION, AND MODE OF FORCED CHOICE PRESENTATION IN THE ALBINO RAT

by

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Abstract

Albino rats were trained under either high (23.5 h) or moderate (18 h) water deprivation, to run in a two choice discrimination chamber for water versus sucrose (8% or 20%) with the position of each incentive fixed. Half the animals were run in an alternating free and forced choice sequence while for the remaining subjects all trials were forced choice prior to free choice tests. Moderate deprivation resulted in faster running speeds to, and a preference for, sucrose. High deprivation animals showed no preference. Mode of training had no significant effect on choice behaviour for either deprivation group. Deprivation conditions for the two groups were then switched and the animals retested. Moderate deprivation animals switched to high deprivation maintained a sucrose preference. Highly deprived animals switched to moderate deprivation continued to show no preference for either solution. The results are discussed in terms of various incentive theories.

PREFACE

I would like to dedicate this thesis to my advisor, Dr. Jerome Cohen, who gave so freely of his time in assisting me on this project. He helped me persevere when things seemed most difficult.

I would also like to thank my committee members Dr. M. Adelman, Dr. T. Hirota and Dr. B. Rourke for their willing participation.

A special thanks goes out to Jocelyn Fleming for her efficiency and patience in typing the manuscript.

A final acknowledgement must go to my wife, Karen and children, Amanda and Aaron, whose encouragement helped me achieve the final goal.

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CHAPTER I

INTRODUCTION

Statement of the Problem

A number of studies have shown that water deprived rats do not demonstrate as strong a preference for sucrose solutions as do food deprived or satiated animals. At the same time, when two differing concentrations of sucrose are both continuously present, thirsty rats do appear to prefer, within certain limits, the higher concentration solution.

In order to explain such results, Beck et al (1972) have proposed an approach-arousal-decay hypothesis. According to this notion, the difference in the capacity of different concentrations to arouse approach behaviour is considered to be smaller under conditions of thirst as opposed to hunger or satiation, thus the acceptability of lower quality incentives tends to be equalized to the approach arousal value of higher quality incentives. Further, the approach arousal value of a given solution is said to decay exponentially as a function of time since the last presentation of the solution. Accordingly, this explains why interruption of incentive presentation results in the breakdown of differential preference.

As a test of the approach arousal hypothesis, Beck and Bidwell (1974) examined sucrose preference under conditions of high food and water deprivation using an instrumental paradigm. They reasoned that since by its very nature an instrumental paradigm involves interruption of incentive presentation, sucrose preferences were improbable. Their results indicated that food deprived animals demonstrated a complete (100%) preference for sucrose over water, while the preference of water deprived animals did not depart significantly from chance (50%), thus providing support for the approach arousal hypothesis.

In contrast to the above, a recent experiment by Cohen and Oostendorp (unpublished research - University of Windsor), showed that under certain conditions, highly water deprived rats i.e. 23.5 h, do in fact prefer sucrose over water. Cohen and Oostendorp have suggested that Beck and Bidwell (1974) failed to obtain a sucrose preference because their procedure did not allow Ss to learn the correct location of the differing incentives (water vs sucrose).

The purpose of the present study is to resolve these differing experimental results and further to evaluate the Cohen and Oostendorp suggestion.

Summary of Theory and Related Research

It may be useful from the onset to define the term incentive as distinguished from reward and/or reinforcement. In general most theorists have defined incentive as a hypothetical construct which refers to an organism's expectation of reward, (c.f. Spence 1956, Logan 1960, Bolles, 1967). In contrast, reward or reinforcement, generally interchangeable terms, are used to describe events, such as when a thirsty animal receives water for making a particular response. In such an instance, the empirical relationship between response and outcome, i.e. reward, defines the condition of reinforcement.

Systematic research into the mechanism of incentive can be traced back to as early as the 1920's. For example, Simmons (1924) ran groups of rats in mazes for different rewards and demonstrated that such animals would learn the maze faster for some rewards i.e. bread and milk, than for others i.e. sunflower seeds, despite the fact that physiological drive level i.e. hunger, was held constant for all groups. This and similar evidence led Tolman (1932) to the notion that an animal's performance was a joint effect of drive (physiological state), and the expectation of receiving a particular reward (incentive). Tolman believed that an animal did not necessarily acquire a simple stimulus-response association but rather learned the significance of cues in the environment in terms of what to expect beyond such cues.

This expectancy notion contrasts sharply with the ideas of strict S-R learning theorists who have argued in favour of an associative connection between a stimulus and a response as the basis for learning. Hull (1952) for example, proposed that when an animal makes a consumatory response (Rg) in the goal box of an apparatus, the Rg becomes conditioned via a classical conditioning process to all the stimuli present in the goal box situation. Stimuli in the start box which are in any way similar to those in the goal box, will elicit a fraction of the goal response (rg) which in turn has proprioceptive consequences (sg) which associatively determine behaviour. Thus via a sequence of rg-sg stimulations an animal learns that reinforcement is present in the goal box. This position requires, of course, that reinforcement is necessary for learning to occur.

Tolman argued that reinforcement was not always necessary and supported his case with reference to latent learning experiments. Tolman and Honzik (1930) for example, showed that rats run in a maze for ten days without reinforcement would, upon introduction of reward, rapidly decrease errors as compared to naive control animals, which, of course, suggests that some learning occurred in the absence of reinforcement. While it is true that some experiments in this area have produced negative results, according to Kimble (1961) such outcomes are in the minority, suggesting, at least, that latent learning is a reasonably dependable phenomenon. In any case, Tolman's work did draw attention to the concept of incentive and its effect upon performance and learning.

Crespi (1942), in a classic experiment, ran groups of hungry rats in a straight runway to differing (large vs small) amounts of food. After 20 trials the rewards were shifted, such that Ss previously given large amounts were given small amounts and vice versa. As a result of such manipulations, performance, as measured by latency and running speed, shifted abruptly, i.e. within one or two trials, to a different and appropriate level of performance. In the light of such evidence, which had been replicated by Zeaman (1949), Hull was forced to reevaluate his drive (D) X habit strength (H) = excitatory potential (sEr) formula by introducing a motivational variable (K). Hull (1952) assumed that bodily need was basic to behaviour. Presumably bodily needs generated drives i.e. hunger, thirst, etc. which activated responses. If, by chance, such activation resulted in drive reduction, for example via reinforcement, the drive stimuli and response stimuli became connected via association and thus in subsequent similar situations drives would evoke the appropriate responses. Hull (1952) conceived of K as a function of Rg, which in turn was dependent upon the amount or quality of reinforcement. Thus the intensity of Rg became one of the variables which influenced the vigor of the rg - sg mechanism.

Hull tied K into his basic formula in a multiplicative fashion, i.e. sEr = D x sHr x K, hence K was seen as influencing excitatory strength. Spence (1956) proposed that D and K were not multiplicative but rather additive. A number of experiments apparently support Spence's notion. For example, Reynolds and Anderson (1961) ran two groups of rats, one under high food deprivation and the other under low, in a T maze with a large amount of food on one side and a small amount on the other. If D and K multiply then the high drive group should have learned the discrimination more rapidly, however, results showed that acquisition was equal for both groups suggesting support for the additive hypothesis.

Thus far we have examined theories of incentive motivation based primarily on studies in which animals have been food deprived and further which involved manipulation of amount of reinforcement. More recently investigations in this area of research have tended to emphasize quality of reward. Specifically this has involved manipulation of sucrose concentrations to both food and water deprived subjects. Credit for the first investigation using this procedure is generally given to Guttman (1953) who demonstrated that rats would bar press at a greater rate for higher concentrations of sucrose as opposed to lower concentrations. Similar results have also been reported by a number of other investigators (Collier and Myers, 1961; Beck, 1963; Beck and Ellis, 1966; Rosen and Jacobs, 1968; Oakley, 1965). Using free choice paradigms, that is, where animals are allowed to choose between simultaneously presented incentives, both hungry and satiated Ss tend to choose higher concentration sucrose solutions (Beck, Self and Carter, 1965; Beck et al, 1972; Cohen and Tokeida, 1972).

While it seems reasonable to assume that hungry animals might be motivated by nutritional concerns, hence their preference for sucrose, it has been suggested that taste is also an important factor. According to Sheffield and Roby (1950) the reward value of a sweet taste increases with food deprivation. Further, non deprived animals, in the absence of any obvious need, will consume large quantities of sweet solutions including sucrose, glucose and saccharin (Ernits and Corbit, 1973; Navarik and Strouthes, 1969).

Based on findings that rats prefer sweetness, Young (1955, 1961), has proposed a relatively simple theory of incentive motivation based on the notion of affective arousal. Since animals "like" sweet tastes, the sweeter the taste, the more the animal is aroused and thus the more vigourous is the consumatory behaviour. Any stimulus which is consistently paired with "affective arousal" comes to elicit incentive motivation and hence arousal. Such motivation can also be negative as in the case of aversive stimuli such as bitter substances. Thus, for Young, learned instrumental responses are entirely a function of incentive, and drive level merely serves to increase the incentive value of the goal object.

A recent article on saccharin preferences in the rat by Mook (1974) has called into question the hedonic (i.e. rats simply like sweet substances), interpretation of choice behaviour. Mook argues that preferences for sweet solutions may reflect the informational properties of sweetness. In other words sweetness may act as a cue which signals that a particular solution has nutritional value. In a series of studies, Mook (1974) demonstrated that rats seldom prefer a saccharin sweetened liquid diet over a bland liquid diet, which suggests that when other nutritional cues are present, sweetness becomes redundant and consequently is ignored. This interpretation shifts the focus of attention from the motivational to the sensory properties of taste.

With water deprived animals the situation appears more complex. Since rats deprived of water reduce their food intake, (Bolles, 1961; Collier and Knarr, 1966), presumably they too, on the basis of nutritional concern, might prefer higher concentration sucrose solutions. This is not, however, always the case. In studies employing a forced choice paradigm, i.e. Ss are forced to respond for only one type of incentive during a given trial or session, water deprived animals show no significant differences in bar press rates for a higher as opposed to a lower concentration incentive (Beck, 1963; Collier, 1964; Oakley, 1965; Beck and Ellis, 1966).

At the same time there are indications, that under certain conditions, the thirsty rat does prefer sucrose. Beck and Nash (1969) presented pairs of different concentration sucrose solutions simultaneously in 20 min. tests and found preferences for the more concentrated solution in each pair. Such preferences were not evident, however, until the second minute of the session. Cohen and Tokeida (1972), obtained similar results in a 15 min. two bottle preference test of sucrose vs water. With a one lick test results were reversed. However the preference for water over sugar could be changed to a sucrose preference if the thirsty animals were pre-watered. Cohen and Tokeida (1972) have suggested that the choice between sucrose and water in water deprived animals is controlled by the total amount of hydration that occurs during the test; i.e. with adequate hydration, (15 min. test), sucrose preference is shown; with inadequate hydration, (one lick test), water is preferred.

Beck, Nash, Viernstein and Gordon (1972) have shown that with progressively shorter intervals of repeated stimulus presentation (continuous to 10 sec. per min.) in 20 min. two choice exposure tests, thirsty rats dropped from a 90% to a 50% preference for sucrose over water. In order to explain such results, Beck et al (1972) have proposed the approach-arousal-decay hypothesis. According to this notion, different incentives have differing capacities for producing approach arousal behaviour. For example, under conditions of hunger or satiation a higher concentration sucrose solution produces greater approach arousal hence an animal will prefer it to a lower concentration. Under conditions of thirst however, the difference in approach arousal value of different sucrose concentrations is much less, that is, a lower conentration is as acceptable or nearly acceptable as a higher concentration. In addition, the approach arousal value of a given solution decays rapidly (i.e. as an exponential function of time since last presentation), thus as the time between presentations of differing incentives increases, the likelihood of preferring one over the other decreases.

As a further test of the approach arousal hypothesis, Beck and Bidwell (1974) examined sucrose preference using an instrumental paradigm. They reasoned that since an instrumental paradigm involves discrete trials, sucrose preference effects were improbable due to the interruption of incentive presentation. Two groups of rats, one group 23 hr. food deprived, the other 23.5 hr. water deprived were run for 6 massed trials daily in a two choice situation with the positioning of each incentive held constant (water vs 8% sucrose solution). An alternation procedure was used such that for each daily session, Trials 1, 3 and 5 were free choice and trials 2, 3 and 6 were forced to the side opposite the immediately preceding choice. Deprivation conditions for the two groups were then reversed. The results indicated that when animals were food deprived, responding on free choice trials was 100% in favor of the sucrose solution. In contrast, while water deprived, preference did not depart significantly from a 50% choice hence providing support for the approach arousal hypothesis.

As an extention of the Beck and Bidwell (1974) study, Cohen and Oostendorp (unpublished research - University of Windsor) investigated the generalization of drive related incentive approach behaviour between free and forced choice conditions. Beck and Bidwell (1974) had measured only free choice responding whereas the Cohen and Oostendorp study allowed additionally for examination of forced choice responding. Animals were trained under either high (23.5 hr.) or moderate (18 hr.) water deprivation to a simultaneous two choice brightness discrimination problem with S+ associated with the position of each incentive. The position of the incentives was held constant (water vs 20% sucrose). Upon reaching criterion (not more than two errors in 24 trials), for the discrimination task, animals were tested for incentive preference by making both incentives positive. Under forced choice conditions only moderately deprived animals showed higher sucrose incentive approach responding as measured by fewer errors and greater running speed to S+ when located at the sucrose position. On free choice trials however, highly deprived animals as well as moderately deprived showed a preference for sucrose.

The above result apparently contradicts the approach arousal hypothesis since highly deprived Ss should not have shown a sucrose preference. Cohen and Oostendorp have suggested that the training procedures used by Beck and Bidwell (1974) may have prevented thirsty animals from learning the location of the differing incentives. They have pointed out for example, that when thirsty Ss were satiated and rerun in the procedure, they showed only slow and erratic sucrose preference acquisition. Further, satiated animals when made thirsty, continued to show sucrose preferences over several sessions.

Research has shown that highly deprived rats are unable to utilize redundant dimensions in discrimination tasks (Cohen, Stettner and Michael, 1969; Cohen and Telegdy, 1970). Telegdy and Cohen, (1971), demonstrated that cue utilization differences between deprivation levels appeared to be a learning rather than a performance effect. Beck and Bidwell's (1974) use of alternating free and forced choice trials may have prevented highly deprived animals from learning the location of the incentives. It is also possible that in the Cohen and Oostendorp study, highly deprived animals received so much forced training that acquisition of incentive positions became possible. Further, the use of different incentives i.e. Beck and Bidwell (0 vs 8%); Cohen and Oostendorp (0 vs 20%); may also be a relevant factor.

The purpose of the present study is to evaluate the Cohen and Oostendorp suggestion and further to provide a resolution of these differing experimental results. An appropriate design is to test two groups of animals on free choice trials following training in which one group is run in a series of alternating free and forced choice trials (alternation) vs a second group which receives only forced choice training (sequential). Half of each group would be run to 0 vs 8% sucrose and half to 0 vs 20% sucrose. If each group includes both moderate and highly deprived animals and assuming the Cohen and Oostendorp suggestion is valid it is predicted that:

(1) moderately deprived animals in both alternation and sequential groups will show preference for sucrose on free choice trials.

(2) highly deprived animals in the sequential group will display a preference for sucrose while those in the alternation group will demonstrate nonpreferential responding.

In addition this design will allow for a determination of the effect on running speed of the different incentive values under different deprivation conditions. The present study also allowed an evaluation of the two incentive levels (0% vs 8%; 0% vs 20%) on the above preference measures.

CHAPTED II

METHOD

Subjects

Ninety-six male albino rats of the Wistar strain from the breeding colonies of Woodlyn Farms, Guelph, Ontario, Canada, approximately 80 days of age at the time of pretraining, were used in the experiment. During the course of the study two animals failed to become habituated to the discrimination apparatus and had to be replaced by animals from the same breeding stock.

Apparatus

A simultaneous two-choice discrimination box (see Figure 1) similar to that used by Cohen and Oostendorp was used in the present study. The apparatus was 30 cm in height. It was divided into two basic areas, a decision chamber 47 X 42 cm and two goal chambers, each 28 X 21 cm. Entry by the animals into the decision chamber was gained through a start box 12 X 8 X 8 cm, opposite the wall containing the doorway openings to the goal chambers. A manually operated clear plastic guillotine door was lifted to expose the rat to the decision chamber. The side walls of the decision chamber extended from the start box outward to the edge of the wall containing the openings to the goal chambers and

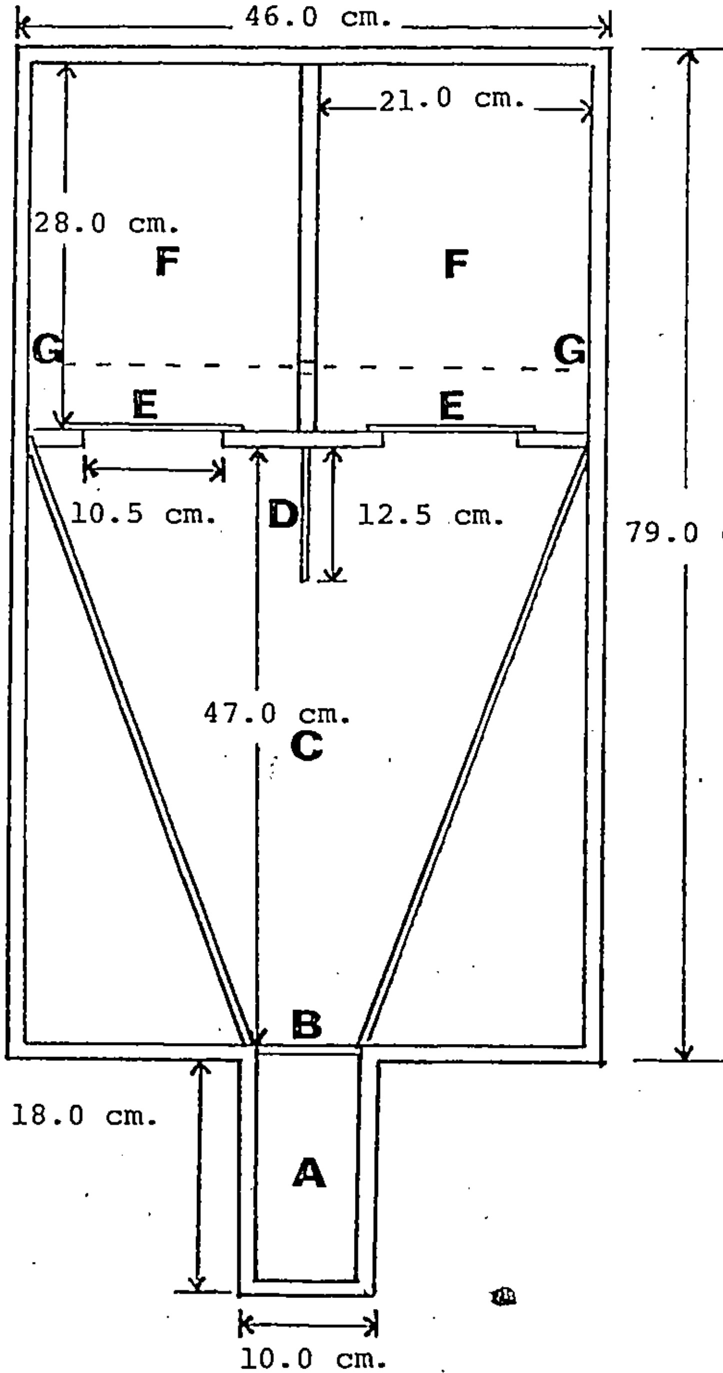

Figure 1. Floor Plan of Discrimination Box. After placement in the starting box (A) the guillotine door (B) is raised and the animal is allowed to enter the decision chamber (C). Opening of a goalbox door (E) breaks the photobeam (G) in the goal chamber (F). The approach areas to the goal chambers are separated by a plexiglass divider (D).

formed a V shaped floor space. On the inner side of the goal chamber doorways were removable, side-hinged doors (10 X 10 cm) which, as required, could be locked in a closed position. Between the two stimulus doors was a 12 X 30 cm clear plastic divider. On forced choice trials, one door was positioned in the appropriate goal chamber and locked shut. On free choice trials, both goal chamber openings were without doors. Each goal chamber contained a metal drinking tube. The entire apparatus was painted flat grey. A 100 watt incandescent light bulb, located directly above the start box opening, provided the only illumination of the apparatus.

A microswitch above the guillotine start box door and a Lafayette photoelectric beam unit behind the goal box doorways allowed for the recording of running time in the following manner: When an animal pressed his nose against the start box door, the door was manually lifted up to the microswitch. The microswitch started a Standard Electric stop clock (0.01 sec accuracy) which continued to run until the animal entered the goal box doorway. When the animal entered the doorway it interrupted the photoelectric beam, 4 cm beyond the doorway, which stopped the clock. Time from opening of the start box door by the experimenter to the breaking of the photo electric beam by the animal was defined as the animal's running time. All sucrose solutions were made according to wt/vol. with tap water at room temperature.

Procedure

The procedure was divided into four phases: (1) pretraining (2) training (3) testing (4) drive shift and retesting.

Phase (1) - For the first two days, animals were provided with food (Purina Lab Chow) and water ad lib in their home cages. During this period animals were handled and gentled for 5 minutes per day. On the third day the subjects were randomly divided into two groups and placed on either a 23.5 hr or 18 hr water deprivation schedule. At the same time, and for three days, the animals were introduced to the discrimination apparatus and allowed to explore for a total of 5 minutes. The 5 minutes consisted of a 2 minute exploration trial, followed by a second trial, followed by a 1 minute trial. During these trials the animals were allowed to drink only one incentive solution, 8% or 20% sucrose, in the goal chambers to a maximum of 1 minute. To insure equal exposure to both sources of reinforcement E placed subjects in both goal chambers, when necessary on any given trial. Thus there were four independent deprivation - concentration groups (n=24): high - 8%, High - 20%, moderate - 8%, moderate - 20%.

Starting on day 6 and for 4 days, Ss were run 4 trials per day to their respective incentives, 8% or 20% sucrose reinforcement. All trials were forced choice; i.e. one door positioned and locked. All Ss were run in an alternation sequence; i.e. Left, Right, Left, Right, etc..During this and subsequent phases, animals were run in groups of 16 in a sequence such that all animals were run once before any animal was given a second trial. This procedure generated an intertrial interval of approximately 10 to 12 minutes.

Phase (2) - All animals were run for 10 days, 6 trials per day, during the training phase. Ss within each deprivation group were randomly divided into two training groups, alternation and sequential with an equal number of high (23.5 hr water deprivation) and moderate (18 hr water deprivation) Ss in each group (n=24). Animals in the alternation group were run in a free choice, forced choice alternating sequence. On a free choice trial both goal chambers were without doors and animals were allowed to run to either goal chamber for either water or sucrose reinforcement. On a forced choice trial, the door to the chamber chosen on the previous trial was locked shut forcing the animal to run to the opposite goal chamber for reinforcement. Animals in the sequential group were run for 6 forced choice trials per day.

Each animal in the sequential group was yoked to a member of the alternation group and thus the positioning of the locked door for a given animal in the sequential group was determined by its yoked counterpart in the alternation group. This procedure insured that a particular sequence of position responding was replicated for both deprivation conditions and for both training procedures. For example, suppose that a highly deprived animal in the alternation group ran in the following sequence; left (L), right (R), R, L, L, R, in alternating free and forced choice trials. Yoking insured that at least one animal in the sequential group ran in the same pattern of left-right responses, and thus differences between the alternation and sequential groups could not be attributed to differences in the pattern of responding. With respect to deprivation level, counterbalancing procedures were carried out semi-randomly so that half of the highly deprived animals in the sequential group were yoked to high alternation and the rest to moderate alternation. The same division occurred for moderately deprived animals. Position of the different incentives was fixed throughout the entire experiment with the location of sucrose counter-balanced, either left or right, for the different subjects in each subgroup.

It will be recalled that Beck and Bidwell (1974) used 0% vs. 8% sucrose while Cohen and Oostendorp used

0% vs. 20%, consequently, in this study, half the animals were run to 0% vs. 8% and half to 0% vs. 20%.

Phase (3) - The test phase consisted of 6 trials per day for 4 days. For the alternation group no change in procedure was instituted, that is, test trials were identical to training trials. For the sequential groups, Ss were given alternating free and forced choice trials in the same manner as for the alternation group.

Phase (4) - Following completion of test trials, the animals were shifted to their opposite deprivation state; that is, moderately deprived animals were placed on a 23.5 hr deprivation schedule, and highly deprived animals were placed on an 18 hr schedule. Ss remained in their home cages for 3 days in order to adapt to their new deprivation schedules. Animals were then retested using the same procedure as in phase (3). This deprivation level shift allowed for the possibility of determining if choice behaviour was a learning or performance phenomenon. If a particular animal showed no preference for either sucrose or water under high deprivation but upon being shifted to moderate deprivation showed a definite preference for one or the other of the two incentives then we might infer that deprivation level affected only performance rather than learning. Therefore, this procedure allowed us to determine if the animal had learned the position of the two incentives.

Throughout each phase of the experiment E recorded the running time on each trial to the nearest 0.1 sec. and the goal box choice on free choice trials.

CHAPTER III

Results

Running Speed

During the training, testing and retesting phases of the experiment, running times on each trial were measured to the nearest 0.1 sec. and transformed to reciprocal speed scores. Reciprocal speed scores were used to normalize skewed running time scores and permitted parametric statistical analysis (Winer, 1971). A mean speed score to each incentive position over a block of 2 days (6 trials to each incentive position), was then calculated for each subject.

Figure 2 presents the mean running speed to sucrose (8% or 20%) vs. water (0%) for each experimental group (n=12), by two day trial blocks during each phase of the study. It can be seen from Figure 2 that training mode had little effect on running speed. Analysis of variance also failed to uncover any main or interaction effects with this factor as is noted below. Therefore, a third figure, with mode of training collapsed over the other factors was constructed. Descriptions of observed differences will thus be generated from Figure 3. As some of the animals (sequential groups) experienced a

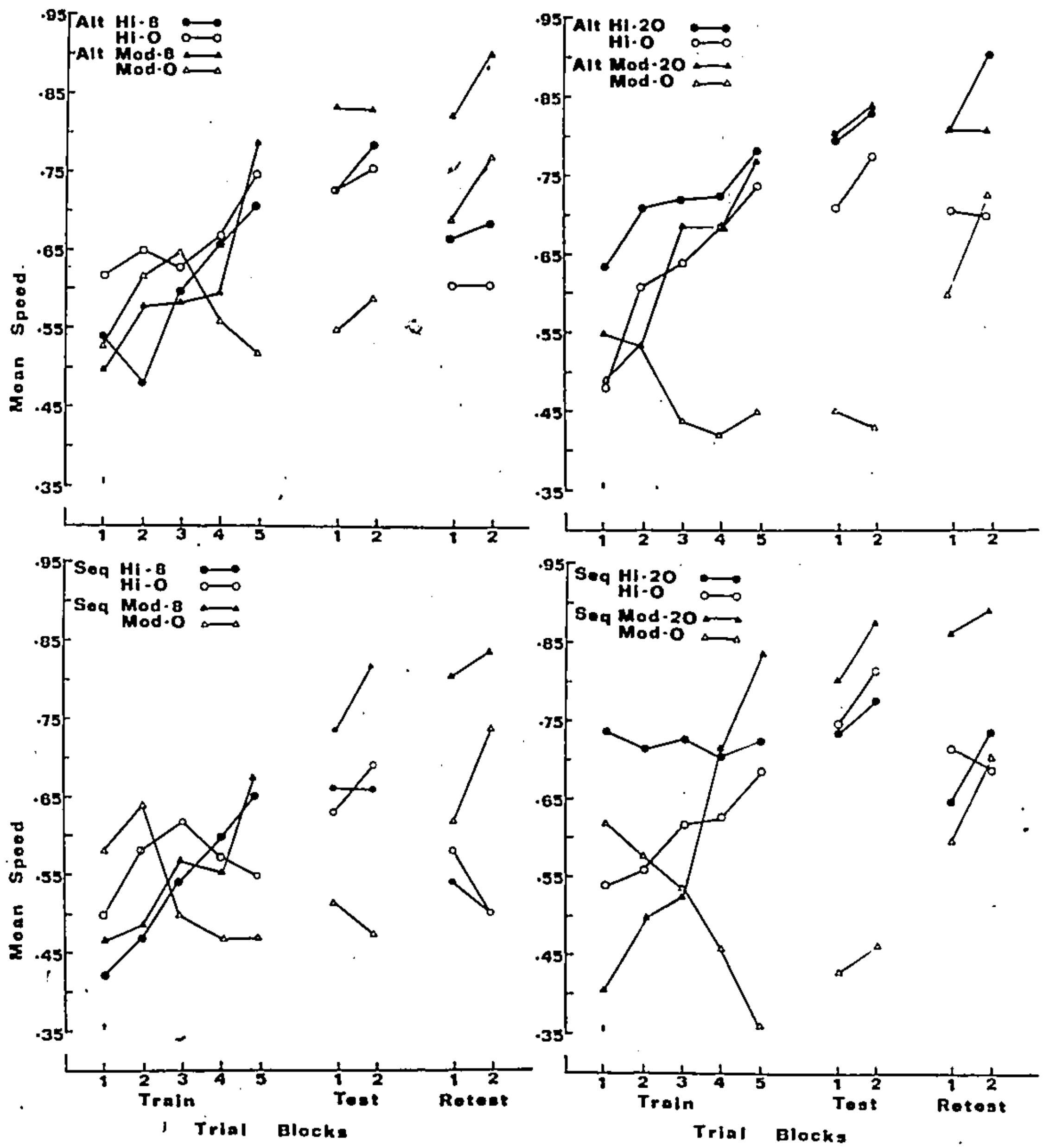

Figure 2. Mean Running Speed to Each Incentive Position for Each Deprivation Level-Sucrose Concentration -Mode of Training Group by Two Day Trial Blocks.

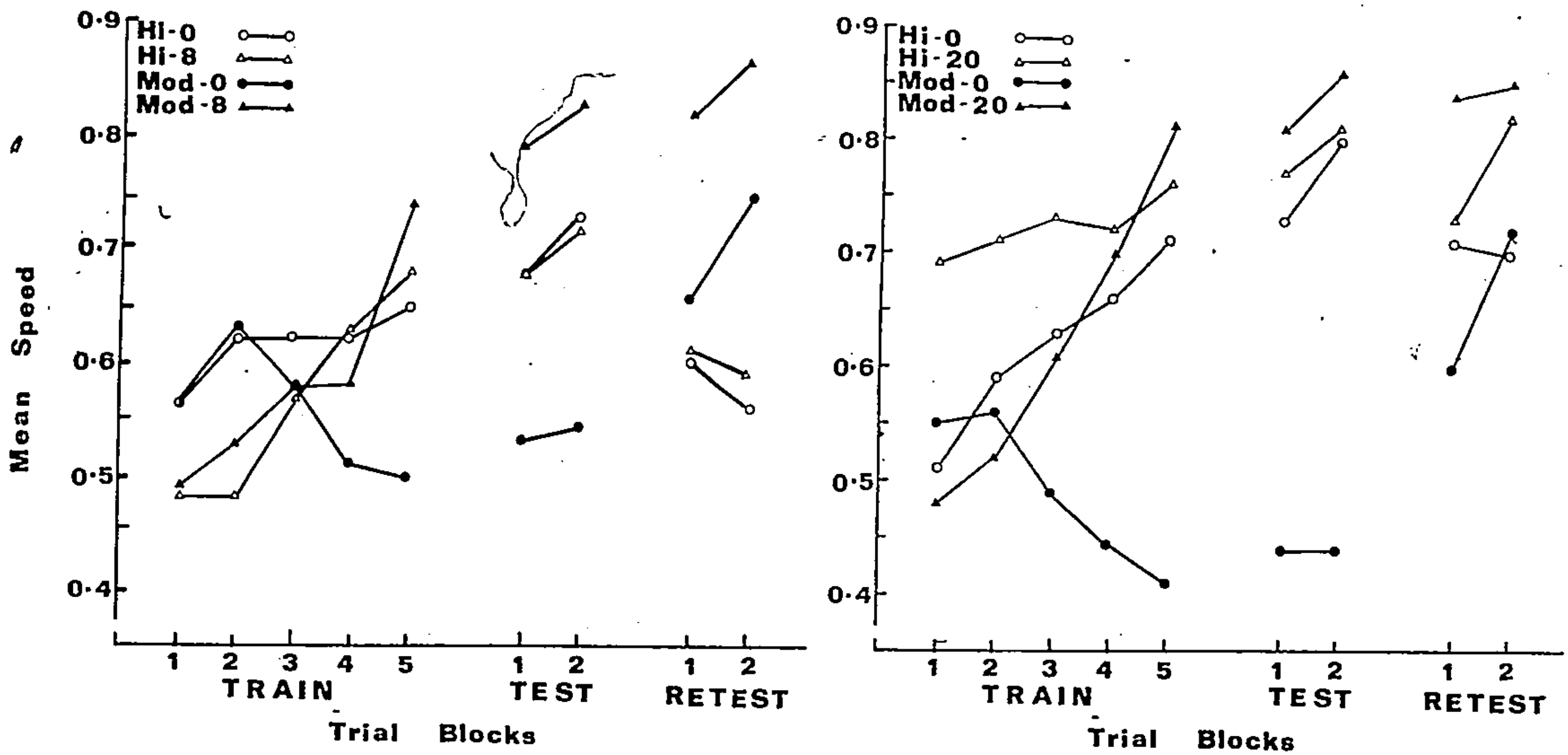

Figure 3. Mean Running Speed to Each Incentive Position for Each Deprivation Level-Sucrose Concentration Group by Two Day Trial Blocks

change in type of trials from training to the test phase, direct statistical comparisons between these phases could not be carried out due to a nested factor of mode of training. Instead, separate analyses for each phase of the study were conducted and will be reported in sequence.

Training

As seen in Figure 3, highly water deprived animals developed a steady increase in running speed to each incentive position over training blocks. For highly deprived animals that experienced the 20% concentration, running was initially faster to the sucrose than water position although this speed difference decreased as training progressed. In contrast, high deprivation animals in the 8% sucrose concentration group initially ran faster to water than sucrose although this speed difference disappeared by trial block 4. Moderately water deprived animals behaved much differently from highly deprived animals. Initial speeds were not different. Over training blocks, however, moderately deprived rats increased speeds to the sucrose and decreased speeds to the water position. This pattern appeared more quickly for moderately deprived animals that experienced the 20% sucrose concentration. By the end of the training session, highly deprived animals were running more quickly to the water incentive than moderately deprived animals. Both deprivation groups appeared to run as fast to their respective sucrose positions.

A Deprivation Level X Mode of Training X Sucrose Concentration X Incentive Position (repeated measure) X Training Trial Blocks (repeated measure) ANOVA (Table 1a p. 29, 30) confirmed the above observations. There were significant main effects for Deprivation Level ($F(1,88) = 5.57$, $p < .05$), Incentive Position ($F(1,88) = 4.97$, $p < .05$) and Trial Blocks ($F(4,352) = 17.45$, $p < .01$) and significant interactions of Sucrose Concentration X Incentive Position ($F(1,88) = 6.94$, $p < .05$), Incentive Position X Trial Blocks ($F(4,352) = 11.69$, $p < .01$), Deprivation Level X Incentive Position X Trial Blocks ($F(4,352) = 9.69$, $p < .01$) and Deprivation Level X Sucrose Concentration X Incentive Position X Trial Blocks ($F(4,352) = 3.53$, $p < .05$).

In order to investigate the 4 way interaction, a series of individual comparisons (Newman-Keuls Procedure) were conducted (Table 1b p. 31, 32, 33). These included comparisons between (1) incentive positions within each sucrose concentration - deprivation group (2) deprivation levels within each sucrose concentration group at each incentive position (3) sucrose concentration within each

Table 1a

Deprivation Level X Mode of Training X Sucrose Concentration X Incentive Position (Repeated Measure) X Training Trial Blocks (Repeated Measure) ANOVA for Mean Running Speed

Source of Variation	SS	df	MS	F
Between Ss	19.903	95		
A (deprivation level)	1.103	1	1.103	5.57*
B (mode of training)	0.322	1	0.322	1.63
C (sucrose concentration)	0.292	1	0.292	1.47
AB	0.016	1	0.016	0.08
AC	0.500	1	0.500	2.53
BC	0.214	1	0.214	1.08
ABC	0.010	1	0.010	0.05
Ss within Groups	17.446	88	0.198	
Within Ss	38.498	864		
D (incentive position)	0.711	1	0.711	4.97*
AD	0.167	1	0.167	1.17
BD	0.006	1	0.006	0.04
CD	0.993	1	0.993	6.94*
ABD	0.127	1	0.127	0.89
ACD	0.030	1	0.030	0.21
BCD	0.028	1	0.028	0.20
ABCD	0.018	1	0.018	0.13
D X Ss within Groups	12.624	88	0.143	
E (trial blocks)	1.395	4	0.349	17.45**
AE	0.152	4	0.038	1.90
BE	0.092	4	0.023	1.15
CE	0.013	4	0.003	0.15
ABE	0.056	4	0.014	0.70
ACE	0.071	4	0.018	0.90
BCE	0.032	4	0.008	0.40
ABCE	0.146	4	0.037	1.85
E X Ss within Groups	6.966	352	0.020	

Table 1a CONTINUED

Deprivation Level X Mode of Training X Sucrose Concentration X Incentive Position (Repeated Measure) X Training Trial Blocks (Repeated Measure) ANOVA for Mean Running Speed

Source of Variation	SS	df	MS	F
DE	1.494	4	0.374	11.69**
ADE	1.239	4	0.310	9.69**
BDE	0.145	4	0.036	1.13
CDE	0.029	4	0.007	0.22
ABDE	0.072	4	0.018	0.90
ACDE	0.451	4	0.113	3.53**
BCDE	0.061	4	0.015	0.47
ABCDE	0.285	4	0.071	2.22
DE X Ss within Groups	11.095	352	0.032	

*$p < .05$
**$p < .01$

Table 1b

Individual Comparisons (Newman-Keuls Procedure)

for Mean Running Speeds for Training Sessions

Comparisons between Incentive Positions within each Deprivation Level - Sucrose Concentration Group
(MSe = 0.039)

	High		Moderate	
Trial Blocks	0% vs. 8%	0% vs. 20%	0% vs. 8%	0% vs. 20%
1	-	**	-	-
2	*	*	-	-
3	-	-	-	*
4	-	-	-	**
5	-	-	**	**

Comparisons between Deprivation Levels within each Sucrose Concentration at each Incentive Position
(MSe = 0.055)

	8%		20%	
Trial Blocks	Hi 0 vs. Mod 0	Hi 8 vs. Mod 8	Hi 0 vs. Mod 0	Hi 20 vs. Mod 20
1	-	-	-	**
2	-	-	-	**
3	-	-	*	-
4	-	-	**	-
5	*	-	**	-

**p < .01; *p < .05; - NS

Table 1b (continued)

Individual Comparisons (Newman-Keuls Procedure)

for Mean Running Speeds for Training Sessions

Comparisons between Sucrose Concentration within each Deprivation Level at each Incentive Position
(MSe = 0.055)

	Sucrose		Water	
Trials Blocks	Hi 8 vs. Hi 20	Mod 8 vs. Mod 20	Hi 8 vs. Hi 20	Mod 8 vs. Mod 20
1	**	-	-	-
2	**	-	-	-
3	*	-	-	-
4	-	*	-	-
5	-	-	-	-

Comparisons between Trial Blocks within each Deprivation Level - Sucrose Concentration Group at each Incentive Position
(MSe = 0.039)

Hi 0% 8% Blocks	1	2	4	3	5
1		-	-	-	-
2			-	-	-
4				-	-
3					-

Hi 8% Blocks	2	1	3	4	5
2		-	-	*	**
1			-	-	**
3				-	-
4					-

Table Ib (continued)

Individual Comparisons (Newman-Keuls Procedure)

for Mean Running Speeds for Training Sessions

Mod 0% Blocks	5	4	1	3	2
5		–	–	–	–
4			–	–	–
1				–	–
3					–

Mod 8% Blocks	1	2	4	3	5
1		–	–	–	**
2			–	–	**
4				–	*
3					**

Hi 0% 20% Blocks	1	2	3	4	5
1		–	–	–	**
2			–	–	–
3				–	–
4					–

Hi 20% Blocks	1	2	4	3	5
1		–	–	–	–
2			–	–	–
4				–	–
3					–

Mod 0% Blocks	5	4	3	1	2
5		–	–	–	*
4			–	–	–
3				–	–
1					–

Mod 20% Blocks	1	2	3	4	5
1		–	–	**	**
2			–	**	**
3				–	**
4					–

$^{**}p < .01$; $^{*}p < .05$; –NS

deprivation level at each incentive position and (4) trial blocks for each deprivation level - sucrose concentration group at each incentive position. The important findings of this analysis are summarized below.

Both highly deprived groups showed initial significant speed differences to the different incentive positions but this disappeared by the third trial block. High deprivation rats ran significantly faster to 20% sucrose than water on block 1 ($p < .01$) and block 2 ($p < .05$) and to water than 8% sucrose on block 2 ($p < .05$). Moderately deprived animals developed significantly faster speeds to the sucrose position as opposed to the water. Moderate 20% animals developed these differences by the third block of trials ($p < .05$ blocks 4 and 5, $p < .01$) while the moderate 8% group only achieved such significant differences by the fifth trial block ($p < .01$).

High deprivation animals ran significantly faster to the water position than moderate deprivation subjects. For 20% sucrose groups this occurred by the third trial block ($p < .05$), while for 8% groups this difference was not significant until the fifth block ($p < .05$). The only significant differences in speed to the sucrose position was found under 20% sucrose where high subjects ran faster than moderate subjects on blocks 1 and 2 ($p < .01$).

Comparisons between sucrose concentrations at each incentive position indicated that highly deprived animals ran faster to 20% sucrose than animals running to 8% on blocks 1, 2 ($p < .01$) and 3 ($p < .05$). Comparisons between trial blocks revealed that moderately deprived subjects were indeed running significantly faster to 20% sucrose by block 4 as compared with block 1 ($p < .01$) and to 8% sucrose by block 5 as compared to block 1 ($p < .01$). The decrease in running speed to water for moderately deprived animals was only significant for the 20% group ($p < .05$). For highly deprived animals increases in speed over blocks were significant to the water position for the 20% group (block 5 vs. block 1, $p < .01$) and to the sucrose position for the 8% group (block 5 vs. blocks 1 and 2, $p < .01$; block 4 vs. block 1, $p < .05$).

Testing

During the test phase, as shown in Figure 3, rats displayed similar speed differences to those found on block 5 of the training phase, that is, little difference in speed to the different incentive positions for highly deprived animals and faster running to sucrose for moderate deprivation groups. Further, moderately deprived groups appeared to be running faster to the sucrose position than highly deprived groups but slower to the water position within each concentration condition. A Deprivation Level X Mode of Training X Sucrose Concentration X Incentive Position (repeated measure) X Test Trial Blocks (repeated measure) ANOVA (Table 2a p. 37, 38) was carried out. Significant main effects for Deprivation Level ($F(1,88) = 5.38$, $p < .05$), Incentive Position ($F(1,88) = 36.78$, $p < .01$) and Trial Blocks ($F(1,88) = 10.73$, $p < .01$) as well as a significant Deprivation Level X Incentive Position ($F(1,88) = 31.86$, $p < .01$) interaction were found.

A series of individual comparisons (Newman-Keuls Procedure) were conducted with the following results (Table 2b p. 39). Moderate deprivation groups ran significantly faster to sucrose than to the water position on both test blocks ($p < .01$). Both high deprivation groups ran significantly faster to the water position than their equivalent moderate deprivation groups ($p < .01$). No other significant differences in speed were found.

Retesting

Two types of analysis were carried out on the retest data. The first analysis was the same as that conducted for the test data, i.e. high and moderate sucrose level groups were compared in the retest situation. This comparison was carried out to determine if the new (switched) deprivation groups behaved similarly to the previous (test) groups. The second type of analysis involved comparing speed changes from the test to the retest sessions. Since the deprivation levels of all animals had been changed, a single overall analysis could not be

Table 2a

Deprivation Level X Mode of Training X Sucrose Concentration X Incentive Position (Repeated Measure) X Test Trial Blocks (Repeated Measure) ANOVA for Mean Running Speed

Source of Variation	SS	df	MS	F
Between Ss	12.848	95		
A (deprivation level)	0.705	1	0.705	5.38*
B (mode of training)	0.133	1	0.133	1.02
C (sucrose concentration)	0.032	1	0.032	0.24
AB	0.010	1	0.010	0.08
AC	0.266	1	0.266	2.03
BC	0.155	1	0.155	1.18
ABC	0.001	1	0.001	0.01
Ss within Groups	11.546	88	0.131	
Within Ss	14.510	288		
D (incentive position)	2.869	1	2.869	36.78**
AD	2.485	1	2.485	31.86**
BD	0.015	1	0.015	0.19
CD	0.120	1	0.120	1.54
ABD	0.025	1	0.025	0.32
ACD	0.064	1	0.064	0.82
BCD	0.015	1	0.015	0.19
ABCD	0.012	1	0.012	0.15
D X Ss within Groups	6.843	88	0.078	
E (trial blocks)	0.118	1	0.118	10.73**
AE	0.008	1	0.008	0.73
BE	0.001	1	0.001	0.09
CE	0.005	1	0.005	0.45
ABE	0.001	1	0.001	0.09
ACE	0.001	1	0.001	0.09
BCE	0.004	1	0.004	0.36
ABCE	0.002	1	0.002	0.18
E X Ss within Groups	0.962	88	0.011	

40

Table 2a CONTINUED

Deprivation Level X Mode of Training X Sucrose Concentration X Incentive Position (Repeated Measure) X Test Trial Blocks (Repeated Measure) ANOVA for Mean Running Speed

Source of Variation	SS	df	MS	F
DE	0.002	1	0.002	0.20
ADE	0.025	1	0.025	2.50
BDE	0.001	1	0.001	0.10
CDE	0.001	1	0.001	0.10
ABDE	0.014	1	0.014	1.40
ACDE	0.002	1	0.002	0.20
BCDE	0.006	1	0.006	0.60
ABCDE	0.021	1	0.021	2.10
DE X Ss within Groups	0.888	88	0.010	

*$p < .05$
**$p < .01$

Table 2b

Individual Comparisons (Newman-Keuls Procedure) for Mean Running Speeds for Testing Sessions

Comparisons between Incentive Position within each Deprivation Level - Sucrose Concentration Group
(MSe = 0.033)

Trial Blocks	High: 0% vs. 8%	High: 0% vs. 20%	Moderate: 0% vs. 8%	Moderate: 0% vs. 20%
1	-	-	**	**
2	-	-	**	**

Comparisons between Deprivation Levels within each Sucrose Concentration at each Incentive Position
(MSe = 0.057)

Trial Blocks	8%: Hi 0 vs. Mod 0	8%: Hi 8 vs. Mod 8	20%: Hi 0 vs. Mod 0	20%: Hi 8 vs. Mod 8
1	*	-	**	-
2	**	-	**	-

Comparisons between Sucrose Concentrations within each Deprivation Level at each Incentive Position
(MSe = 0.057)

Trial Blocks	Sucrose: Hi 8 vs. Hi 20	Sucrose: Mod 8 vs. Mod 20	Water: Hi 8 vs. Hi 20	Water: Mod 8 vs. Mod 20
1	-	-	-	-
2	-	-	-	-

**p < .01; *p < .05, - NS

used due to a nested factor of initial deprivation level. Instead, two separate analysis for each initial deprivation group were carried out.

As seen in Figure 3, during the retest phase, moderate deprivation subjects switched to high water deprivation continued to run faster to sucrose than to the water side. At the same time, speed to the water position appeared to increase compared with speed during testing. Animals switched to moderate deprivation continued to run equally fast to either incentive position with the exception of the 20% sucrose group which appeared to increase running speed to the sucrose side on retest trial block 2. Compared with test speeds, running appeared slower during retest, for 8% groups shifted from high to moderate deprivation. A Deprivation Level X Mode of Training X Sucrose Concentration X Incentive Position (repeated measure) X Retest Trial Blocks (repeated measure) ANOVA (Table 3a p. 41) indicated significant main effects for Deprivation Level ($F(1,88) = 7.85$, $p < .01$), Incentive Position ($F(1,88) = 19.33$, $p < .01$), and Trial Blocks ($F(1,88 = 9.57$, $p < .01$). The following interactions were also significant: Deprivation Level X Sucrose Concentration ($F(1,88) = 6.16$, $p < .05$), Deprivation Level X Incentive Position ($F(1,88) = 5.76$, $p < .05$), Deprivation Level X Trial Blocks ($F(1,88) = 6.86$, $p < .05$) and Deprivation Level X Incentive Position X Trial Blocks ($F(1,88) = 9.23$, $p < .01$).

Table 3a

Deprivation Level X Mode of Training X Sucrose Concentration X Incentive Position (Repeated Measure) X Retest Trial Blocks (Repeated Measure) ANOVA for Mean Running Speed

Source of Variation	SS	df	MS	F
Between Ss	13.332	95		
A (deprivation level)	0.950	1	0.950	7.85**
B (mode of training)	0.282	1	0.282	2.33
C (sucrose concentration)	0.388	1	0.388	3.21
AB	0.187	1	0.187	1.55
AC	0.745	1	0.745	6.16*
BC	0.077	1	0.077	0.64
ABC	0.019	1	0.019	0.16
Ss within Groups	10.684	88	0.121	
Within Ss	9.355	288		
D (incentive position)	1.063	1	1.063	19.33**
AD	0.317	1	0.317	5.76*
BD	0.041	1	0.041	0.75
CD	0.053	1	0.053	0.96
ABD	0.193	1	0.193	3.51
ACD	0.002	1	0.002	0.04
BCD	0.002	1	0.002	0.04
ABCD	0.021	1	0.021	0.38
D X Ss within Groups	4.843	88	0.055	
E (retest trial blocks)	0.134	1	0.134	9.57**
AE	0.096	1	0.096	6.86*
BE	0.007	1	0.007	0.50
CE	0.020	1	0.020	1.43
ABE	0.017	1	0.017	1.21
ACE	0.031	1	0.031	2.21
BCE	0.008	1	0.008	0.57
ABCE	0.004	1	0.004	0.29
E X Ss within Groups	1.189	88	0.014	

Table 3a CONTINUED

Deprivation Level X Mode of Training X Sucrose Concentration X Incentive Position (Repeated Measure) X Retest Trial Bloyks (Repeated Measure) ANOVA for Mean Running Speed

Source of Variation	SS	df	MS	F
DE	0.000	1	0.000	0.00
ADE	0.120	1	0.120	9.23**
BDE	0.001	1	0.001	0.08
CDE	0.001	1	0.001	0.08
ABDE	0.006	1	0.006	0.46
ACDE	0.032	1	0.032	2.46
BCDE	0.004	1	0.004	0.31
ABCDE	0.011	1	0.011	0.85
DE X Ss within Groups	1.139	88	0.013	

$*p < .05$
$**p < .01$

Individual comparisons (Newman-Keuls Procedure) for the retest phase were carried out (Table 3b p.44) and the results summarized below. Both moderate deprivation groups switched to high deprivation continued to run significiantly faster to sucrose than compared to water for both blocks ($p < .01$). Animals switched from high to moderate deprivation developed significantly faster speeds to sucrose than water ($p < .01$, second block) when sucrose was 20% rather than 8% concentration. It should also be noted that moderately deprived animals switched to high deprivation ran significantly faster to 8% sucrose ($p < .01$, both blocks) and water ($p < .01$, block 2) than did highly deprived animals switched to moderate deprivation. This difference was not found for animals that experienced water and 20% sucrose. For high deprivation animals shifted to moderate deprivation, significantly faster running to both incentive positions on both blocks ($p < .01$) was found under the 20% sucrose condition was compared to the 8% concentration. No such differences were found for moderate deprivation animals switched to high deprivation.

In order to make comparisons across the test and retest conditions, two separate Mode of Training X Sucrose Concentration X Incentive Position (repeated measure) X Trial Blocks (repeated measure) analyses of

Table 3b

Individual Comparisons (Newman-Keuls Procedure) for Mean Running Speeds for Retesting Sessions

Comparisons between Incentive Positions within each Deprivation Level - Sucrose Concentration Group
(MSe = 0.027)

	High		Moderate	
Trial Blocks	0% vs. 8%	0% vs. 20%	0% vs. 8%	0% vs. 20%
1	-	-	**	**
2	-	**	**	**

Comparisons between Deprivation Levels within each Sucrose Concentration at each Incentive Position
(MSe = 0.051)

	8%		20%	
Trial Blocks	Hi 0 vs. Mod 0	Hi 8 vs. Mod 8	Hi 0 vs. Mod 0	Hi 20 vs. Mod 20
1	-	**	-	-
2	**	**	-	-

Comparisons between Sucrose Concentrations within each Deprivation Level at each Incentive Position
(MSe = 0.051)

	Sucrose		Water	
Trial Blocks	Hi 8 vs. Hi 20	Mod 8 vs. Mod 20	Hi 8 vs. Hi 20	Mod 8 vs. Mod 20
1	**	-	*	-
2	**	-	**	-

**p < .01, *p < .05, - NS

variance were carried out on (1) highly water deprived groups shifted to moderate deprivation and (2) moderate groups shifted to high deprivation.

For (1) high deprivation groups shifted to moderate, the ANOVA (Table 4a p.46) indicated significant main effects for Sucrose Concentration ($F(1,44) = 7.58$, $p < .01$) and Trial Blocks ($F(3,132) = 11.94$, $p < .01$) plus a Sucrose Concentration X Trial Blocks interaction ($F(3,132) = 3.89$, $p < .05$). These results appear to confirm the data shown in Figure 3, that is, speed to both incentive positions decreased on the retest phase. For the 20% group the same pattern of decreased speed was found on block 1 of retest. However, speed to the sucrose position appeared to increase on block 2 of retest to test levels, while speed to water remained below test levels. It was also found (Table 4b, p. 47) that the 8% group significantly decreased running speed to the water position on both retest blocks from the last test block ($p < .05$). No differences were found for the 20% group.

For (2) moderate deprivation groups shifted to high, the ANOVA (Table 5a p. 48) indicated significant main effects for Incentive Position ($F(1,44) = 59.19$, $p < .01$) and Trial Blocks ($F(3,132) = 15.19$, $p < .01$) and significant interactions for Mode of Training X Sucrose Concentration ($F(1,44) = 5.75$, $p < .05$) and Incentive

Table 4a

Mode of Training & Sucrose Concentration X Incentive Position (Repeated Measure) X Test and Retest Trial Blocks (Repeated Measure) ANOVA for Mean Running Speed High Deprivation Shifted to Moderate Deprivation

Source of Variance	SS	df	MS	F
Between Ss	8.670	47		
A (mode of training)	0.511	1	0.511	3.25
B (sucrose concentration)	1.190	1	1.190	7.58**
AB	0.073	1	0.073	0.46
Ss within Groups	6.896	44	0.157	
Within Ss	10.612	336		
C (incentive position)	0.086	1	0.086	0.80
AC	0.216	1	0.216	2.02
BC	0.029	1	0.029	0.27
ABC	0.037	1	0.037	0.35
C X Ss within Groups	4.729	44	0.107	
D (trial blocks)	0.644	3	0.215	11.94**
AD	0.085	3	0.028	1.56
BD	0.211	3	0.070	3.89*
ABD	0.029	3	0.010	0.56
D X Ss within Groups	2.429	132	0.018	
CD	0.095	3	0.032	2.29
ACD	0.040	3	0.013	0.93
BCD	0.029	3	0.010	0.71
ABCD	0.004	3	0.001	0.07
CD X Ss within Groups	1.949	132	0.014	

*$p < .05$
**$p < .01$

Table 4b

Individual Comparisons (Newman-Keuls Procedure)

between Trial Blocks for Mean Running Speed

High Deprivation Shifted to Moderate

Deprivation

(MSe - 0.030)

0-8

0% Blocks	4	3	1	2
4		-	-	**
3			-	*
1				-

8% Blocks	4	3	1	2
4		-	-	-
3			-	-
1				-

0-20

0% Blocks	4	3	1	2
4		-	-	-
3			-	-
1				-

20% Blocks	3	1	2	4
3		-	-	-
1			-	-
2				-

**p < .01, *p < .05, -NS

Table 5a

Mode of Training X Sucrose Concentration X
Incentive Position (Repeated Measure) X
Test and Retest Trial Blocks (Repeated Measure)
ANOVA for Mean Running Speed Moderate Deprivation
Shifted to High Deprivation

Source of Variance	SS	df	MS	F
Between Ss	12.502	47		
A (mode of training)	0.032	1	0.032	1.14
B (sucrose concentration)	0.083	1	0.083	2.96
AB	0.161	1	0.161	5.75*
Ss within Groups	12.226	44	.028	
Within	18.307	336		
C (incentive position)	5.915	1	5.915	59.15**
AC	0.018	1	0.018	0.18
BC	0.164	1	0.164	1.64
ABD	0.006	1	0.006	0.06
C X Ss within Groups	4.408	44	0.100	
D (trial blocks)	1.413	3	0.471	15.19**
AD	0.010	3	0.003	0.10
BD	0.004	3	0.001	0.03
ABD	0.007	3	0.002	0.06
D X Ss within Groups	4.040	132	0.031	
CD	0.785	3	0.262	23.82**
ACD	0.023	3	0.008	0.73
BCD	0.051	3	0.017	1.55
ABCD	0.047	3	0.016	1.45
CD X Ss within Groups	1.416	132	0.011	

*$p < .05$
**$p < .01$

Position X Trial Blocks (F(3,132) = 23.82, $p < .01$). From examination of Figure 3 it appears that moderate deprivation animals shifted to high deprivation did not change their running speed to sucrose over the four blocks of the test and retest phases. Such animals, however, increased speed to the water side. Individual comparisons between blocks (Table 5b, p. 50) showed that running speed to water on block 2 of retest was significantly faster than blocks 1 and 2 of test ($p < .01$) for both concentration groups. As for block 1 of retest, the 20% group ran significantly faster to water than on blocks 1 and 2 of test ($p < .01$) while the 8% group ran significantly faster than on block 1 of the test phase ($p < .05$).

In summary, analysis of running speed data indicated that

(1) mode of training had no significant effect upon running speed to the different incentive positions

(2) highly water deprived animals, with the exception of some initial differences ran as fast at the water position as to sucrose, regardless of sucrose concentration

(3) when highly deprived animals were shifted to moderate deprivation some reduction in running speed to both incentive positions was noted for 8%

Table 5B

Individual Comparisons (Newman-Keuls Procedure) between Trial Blocks for Mean Running Speed Moderate Deprivation Shifted to High Deprivation

(MSe = 0.032)

0-8

0% Blocks	1	2	3	4	8% Blocks	1	3	2	4
1		-	-	**	1		-	-	-
2			*	**	3			-	-
3				-	2				-

0-20

0% Blocks	1	2	3	4	20% Blocks	1	3	4	2
1		-	**	**	1		-	-	-
2			**	**	3			-	-
3				*	4				-

$**p < .01$, $*p < .05$, - NS

groups while for 20% groups little change in speed was noted except for trial block 2 of the retest where faster running to sucrose occurred

(4) moderately deprived animals developed faster running to sucrose than to water although such differences appeared earlier for 20% groups than for 8% groups

(5) when moderately deprived groups were shifted to high deprivation running speed to the sucrose position was relatively unchanged. However, an increase in speed to the water position was observed.

Choice Data

For each animal, number of sucrose position choices on free choice trials were calculated over blocks of two days (6 free choice trials). Since relatively few water position choices were made, particularly by moderately deprived animals during the test and retest phase, a $\sqrt{x + 0.5}$ transformation (Winer, 1971) was used for all analyses of variance. Figure 4 presents choice data in percent form, i.e. percentage of sucrose choices out of total choices, in two day trial blocks for each phase of the experiment. As with the analysis of running speed data, each phase of the study was analysed separately and will be reported in sequence.

<u>Training</u>

It should be noted that during the training phase

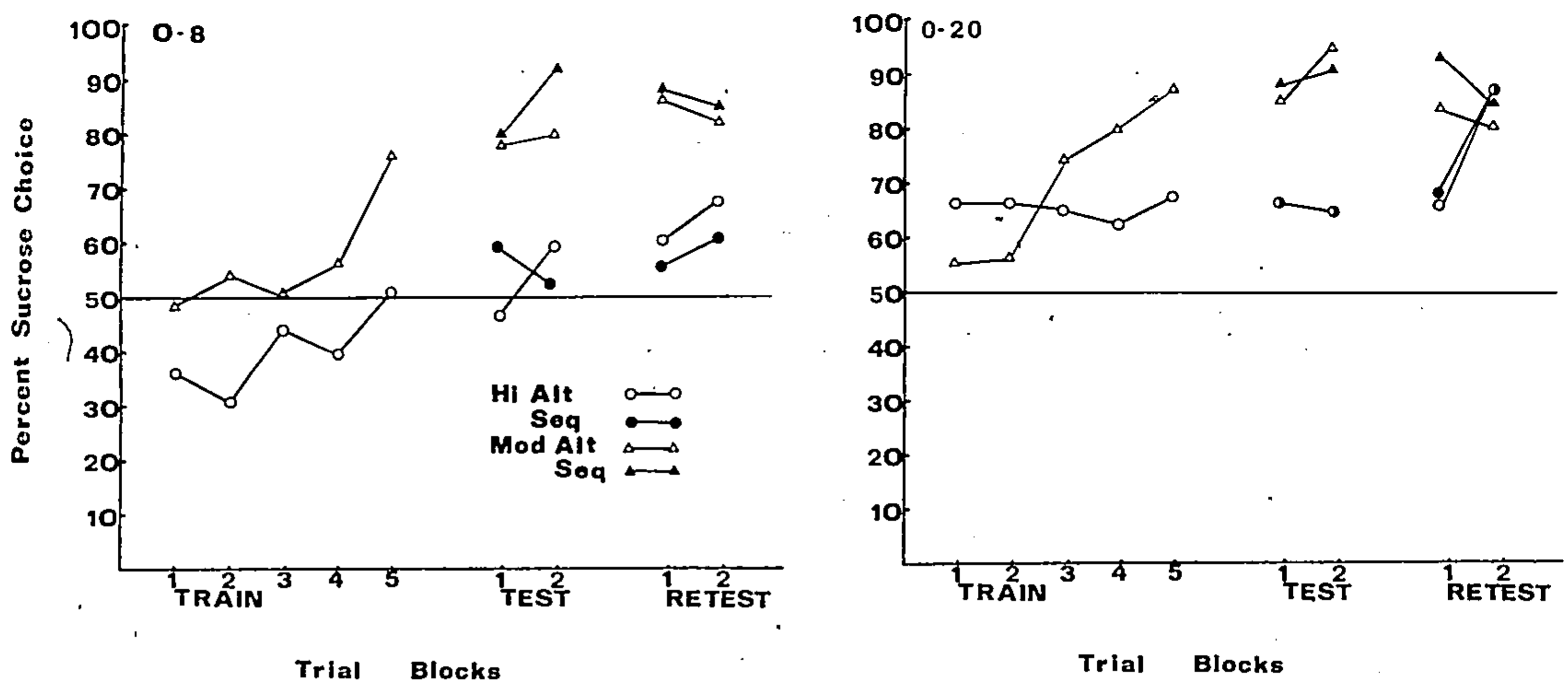

Figure 4. Percent of Choices to Sucrose Incentive for Each Deprivation Level - Mode of Training - Sucrose Concentration Group by Two Day Trial Block.

no data is presented for sequential groups since such groups received only forced choice trials. As shown in Figure 4, the high deprivation 8% group chose the sucrose position on less than 50% of the trials for blocks 1 through 4 and reached the 50% level on block 5. In contrast, the high deprivation 20% concentration group chose the sucrose position approximately 67% of the time over all 5 training blocks. Both moderately deprived groups appeared to develop a decided preference for the sucrose side as training progressed. The 20% concentration group appeared to develop a preference more rapidly than the 8% group and further appeared to chose at a higher rate (88% vs. 78%) by the end of the training phase (block 5).

A Deprivation Level X Sucrose Concentration X Trial Blocks (repeated measure) ANOVA on choice data (Table 6a, p.54) revealed significant main effects for Sucrose Concentration ($F(1,44) = 4.15$, $p < .05$) and Trial Blocks ($F(4,176 = 5.14$, $p < .05$). Individual comparisons (Newman-Keuls Procedure, Table 6b, p.55) indicated that the high deprivation 20% group was selecting the sucrose position significantly more often than the high 8% group on blocks 1 and 2 ($p < .05$). Comparisons between blocks confirmed that moderately deprived groups had increased preference for sucrose as training progressed. For the 20% concentration animals

Table 6a

A Deprivation Level X Sucrose Concentration X Training Trial Blocks (Repeated Measure) ANOVA for Choice Data

Source of Variation	SS	df	MS	F
Between Ss	78.703	47		
A (deprivation level)	2.140	1	2.140	1.36
B (sucrose concentration)	6.521	1	6.521	4.15*
AB	0.975	1	0.975	0.62
Ss within Groups	69.067	44	1.570	
Within Ss	36.769	192		
C (trial blocks)	3.581	4	0.895	5.14*
AC	1.271	4	0.318	1.83
BC	0.265	4	0.066	0.38
ABC	0.977	4	0.244	1.40
C X Ss within Groups	30.675	176	0.174	

*$p < .05$
**$p < .01$

Table 6b

Individual Comparisons (Newman-Keuls Procedure)
for Choice Data for the Training Phase

Comparisons between Deprivation Levels within each Sucrose
Sucroce Concentration
(MSe = 0.453)

8%	Block	1	2	3	4	5	20%	Block	1	2	3	4	5
	Mod vs. Hi	-	-	-	-	-		Mod vs. Hi	-	-	-	-	-

Comparisons between Sucrose Concentrations within each
Deprivation Level
(MSe - 0.453)

Moderate	Block	1	2	3	4	5	High	Block	1	2	3	4	5
	20% vs. 8%	-	-	-	-	-		20% vs. 8%	*	*	-	-	-

Comparisons between Trial Blocks within each Deprivation Level
and Sucrose Concentration
(MSe = 0.174)

Hi 8%

Blocks	2	1	4	3	5
2		-	-	-	-
1			-	-	-
4				-	-
3					-

Hi 20%

Blocks	4	3	2	5	1
4		-	-	-	-
3			-	-	-
2				-	-
5					-

Mod 8%

Blocks	1	3	2	4	5
1		-	-	-	*
3			-	-	*
2				-	-
4					-

Mod 20%

Blocks	1	2	3	4	5
1		-	-	-	*
2			-	-	*
3				-	-
4					-

**p < .01, *p < .05, - NS

block 5 was significantly higher than blocks 1 and 2 ($p < .05$). For 8% concentration animals, block 5 was significantly higher than blocks 1 and 3 ($p < .05$).

In order to determine whether any of the four alternation groups chose the sucrose position more or less often than would be expected by chance a further comparison (Newman-Keuls Procedure) was conducted (Table 6c, p. 57) comparing obtained number of choices for each group with that expected by chance i.e. 3 sucrose choices per 6 trial block = 50%. For high deprivation animals, the 8% sucrose concentration animals chose the sucrose position significantly less than chance on blocks 1 ($p < .05$) and 2 ($p < .01$). By the third block however, these animals did not depart significantly from random responding. The 20% concentration group did not depart significantly from chance on any training phase block. In contrast, moderately deprived groups showed significantly above chance selection of the sucrose position. This occurred for the moderate 8% group on block 5 ($p < .05$) and for the moderate 20% group on both blocks 4 ($p < .05$) and 5 ($p < .01$).

Testing

During the test phase, each alternation group continued to chose the sucrose position at about the same

Table 6c

Individual Comparisons (Newman-Keuls Procedure) between Obtained Number of Sucrose Choices and Expected by Chance (50% - 3 choices/ 6 Free Choice Trials) TRAINING PHASE

(MSe = 0.174)

Blocks	High 8%	Mod 8%	High 20%	Mod 20%
1	*	-	-	-
2	**	-	-	-
3	-	-	-	-
4	-	-	-	*
5	-	*	-	**

**p < .01, * p < .05, -NS

rate as was obtained on block 5 of the training phase. Similarly, sequential groups appeared to make approximately the same number of sucrose choices as their equivalent alternation group. In general, moderate deprivation animals chose sucrose on 80% to 90% of the free choice trials, whereas high deprivation animals chose sucrose between approximately 50% to 68% of the time. A Deprivation Level X Sucrose Concentration X Mode of Training X Trial Blocks (repeated measure) ANOVA (Table 7a, p. 59) confirmed the above observations as the only significant main effect found was for Deprivation Level ($F(1,88) = 23.40$, $p < .01$). Secondary analysis (Newman-Keuls Procedure) failed to uncover any significant differences between concentration groups within each deprivation level or between blocks within each deprivation-sucrose concentration group.

Retesting

During the retest phase, as shown in Figure 4, moderate deprivation groups, now shifted to high deprivation, continued to select the sucrose position at about the same rate as during the test phase, that is, on approximately 80% to 90% of the free choice trials. High deprivation animals shifted to moderate deprivation also appeared to be selecting sucrose as often (55% to 65%) as they did during the test phase with the notable

Table 7a

A Deprivation Level X Sucrose Concentration X Mode of Training X Test Trial Blocks (Repeated Measure) ANOVA for Choice Data

Source of Variation	SS	df	MS	F
Between Ss	45.524	95		
A (deprivation level)	9.267	1	9.267	23.40**
B (sucrose concentration)	1.101	1	1.101	2.78
C (mode of training)	0.153	1	0.153	0.39
AB	0.104	1	0.104	0.26
AC	0.000	1	0.000	0.00
BC	0.083	1	0.083	0.21
ABC	0.011	1	0.011	0.03
Ss within Groups	34.805	88	0.396	
Within Ss	7.220	96		
D (trial blocks)	0.108	1	0.108	1.48
AD	0.077	1	0.077	1.05
BD	0.029	1	0.029	0.40
CD	0.111	1	0.111	1.52
ABD	0.028	1	0.028	0.38
ACD	0.194	1	0.194	2.66
BCD	0.003	1	0.003	0.04
ABCD	0.262	1	0.262	3.59
D X Ss within Groups	6.408	88	0.073	

*$p < .05$
**$p < .01$

Table 7b

Individual Comparisons (Newman-Keuls Procedure)

for Choice Data for the Testing Phase

Comparisons between Deprivation Levels within each Sucrose Concentration
(MSe - 0.234)

8%	Block	1	2	20%	Block	1	2
	Mod vs. Hi	**	**		Mod vs. Hi	*	**

Comparisons between Sucrose Concentration within each Deprivation Level
(MSe = 0.234)

Moderate	Block	1	2	High	Block	1	2
	8% vs. 20%	-	-		8% vs. 20%	-	-

Comparisons between Trial Blocks within each Deprivation Level & Sucrose Concentration
(MSe = 0.073)

	Block 1 vs. Block 2
Hi 8%	-
Hi 20%	-
Mod 8%	-
Mod 20%	-

**p < .01, *p < .05, -NS

exception of the 20% sucrose concentration groups who increased sucrose selection sharply (to approximately the 90% level) on block 2 of the retest phase. A Deprivation Level X Sucrose Concentration X Mode of Training X Trial Blocks (repeated measure) ANOVA (Table 8a, p. 62) indicated significant main effects for Deprivation Level ($F(1,88) = 13.70$, $p < .01$), Sucrose Concentration ($F(1,88) = 4.17$, $p < .05$) and Trial Blocks ($F(1,88) = 4.00$, $p < .05$). In addition, the following interactions were also significant; Deprivation Level X Sucrose Concentration ($F(1,88) = 4.05$, $p < .05$), Deprivation Level X Trial Blocks ($F(1,88) = 19.67$, $p < .01$) and Deprivation Level X Sucrose Concentration X Trial Blocks ($F(1,88) = 4.44$, $p < .05$). Individual comparisons (Newman-Keuls Procedure, Table 8b, p. 63) showed significant differences between moderate and high deprivation levels for both trial blocks under 8% sucrose and block 1 under 20% sucrose ($p < .01$). Further, high deprivation 20% sucrose groups chose the sucrose position significantly more often than the high deprivation 8% sucrose subjects on trial block 2 ($p < .01$). Comparisons between retest trial blocks revealed that only the high deprivation 20% sucrose concentration groups chose sucrose more often on block 2 as compared to block 1 ($p < .01$).

Table 8a

A Deprivation Level X Sucrose Concentration X Mode of Training X Retest Trial Blocks (Repeated Measure) ANOVA for Choice Data

Source of Variation	SS	df	MS	F
Between Ss	27.309	95		
A (deprivation level)	3.371	1	3.371	13.70**
B (sucrose concentration)	1.027	1	1.027	4.17*
C (mode of training)	0.009	1	0.009	0.04
AB	0.997	1	0.997	4.05*
AC	0.166	1	0.166	0.67
BC	0.118	1	0.118	0.48
ABC	0.011	1	0.011	0.04
Ss within Groups	21.610	88	0.246	
Within Ss	4.312	96		
D (trial blocks)	0.144	1	0.144	4.00*
AD	0.708	1	0.708	19.67**
BD	0.076	1	0.076	2.11
CD	0.012	1	0.012	0.33
ABD	0.160	1	0.160	4.44*
ACD	0.007	1	0.007	0.19
BCD	0.002	1	0.002	0.06
ABCD	0.005	1	0.005	0.14
D X Ss within Groups	3.198	88	0.036	

*$p < .05$
**$p < .01$

Table 8b

Individual Comparisons (Newman-Keuls Procedure)

for Choice Data for the Retesting Phase

Comparisons between Deprivation Levels within each Sucrose Concentration
(MSe = 0.141)

8%	Block	1	2	20%	Block	1	2
	Mod vs. Hi	**	**		Mod vs. Hi	**	-

Comparisons between Sucrose Concentration within each Deprivation Level
(MSe = 0.141)

Moderate	Block	1	2	High	Block	1	2
	20% vs. 8%	-	-		20% vs. 8%	-	**

Comparisons between Trial Blocks within each Deprivation Level and Sucrose Concentration
(MSe = 0.036)

	Block 1 vs. Block 2
Hi 8%	-
Hi 20%	**
Mod 8%	-
Mod 20%	-

**p < .01, *p < .05, - NS

In order to examine choice data over both test and retest conditions two separate Sucrose Concentration X Mode of Training X Trial Blocks (repeated measure) ANOVA (Tables 9a, p. 65, 10a, p.66) were required since initial deprivation level would be nested in one overall analysis. Analysis of variance for both shift groups revealed no significant effects. The sharp increase in sucrose choices for the high deprivation shifted to moderate deprivation (20% group) on block 2 of retest suggested additional analyses. Indeed, comparisons (Newman-Keuls Procedure) between concentration groups for high shifted to moderate deprivation, revealed significantly ($p < .05$) more sucrose choices under 20% sucrose as compared with 8% sucrose on block 2 of the retest phase (Table 9b, p. 66).

In order to determine which, if any, of the groups were responding to the sucrose position above chance levels an additional analysis (Newman-Keuls Procedure) was conducted comparing obtained number of sucrose choices with that expected by chance. In order to generate the appropriate error terms for the Newman-Keuls Procedure two possibilities were apparent. In the first case such terms could be calculated from the ANOVA's of each separate phase (Tables 7a and 8a) or alternately from the ANOVA's based on initial deprivation level across test and retest phases (Tables 9a and 10a).

Table 9a

A Sucrose Concentration X Mode of Training X Test and Retest Trial Blocks (Repeated Measure) ANOVA for High Deprivation Shifted to Moderate Deprivation

Source of Variation	SS	df	MS	F
Between Ss	42.405	47		
A (sucrose concentration)	2.881	1	2.881	3.21
B (mode of training)	0.002	1	0.002	0.00
AB	0.016	1	0.016	0.02
Ss within Groups	39.506	44	0.898	
Within Ss	42.107	144		
C (trial blocks)	2.130	3	0.710	2.41
AC	0.399	3	0.133	0.45
BC	0.439	3	0.146	0.58
ABC	0.254	3	0.085	0.29
C X Ss within Groups	38.885	132	0.295	

*$p < .05$
**$p < .01$

Table 9b

Individual Comparisons (Newman-Keuls Procedure)

for Choice Data High Deprivation Shifted to

Moderate Deprivation

Comparisons between Sucrose Concentration by Test & Retest Trial Block
(MSe = 0.445)

Block	1	2	3	4
8% vs. 20%	-	-	-	*

Comparisons between Test & Retest Trial Blocks within each Sucrose Concentration Group
(MSe = 0.295)

	Block	1	2	3	4
8%	1		-	-	-
	2			-	-
	3				-
20%	1		-	-	-
	2			-	-
	3				-

$^{**}p < .01$, $^{*}p < .05$, - NS

Table 10a

A Sucrose Concentration X Mode of Training X Test and Retest Trial Blocks (Repeated Measure) ANOVA for Choice Data Moderate Deprivation Shifted to High Deprivation

Source of Variation	SS	df	MS	F
Between Ss	7.686	47		
A (sucrose concentration)	0.138	1	0.138	0.83
B (mode of behaviour)	0.195	1	0.195	1.17
AB	0.005	1	0.005	0.03
Ss within Groups	7.348	44	0.167	
Within Ss	29.264	144		
C (trial blocks)	0.291	3	0.097	0.45
AC	0.135	3	0.045	0.21
BC	0.010	3	0.003	0.01
ABC	0.216	3	0.072	0.33
C X Ss within Groups	28.612	132	0.217	

*p < .05
**p < .01

Table 10b

Individual Comparisons (Newman-Keuls Procedure)

for Choice Data Moderate Deprivation Shifted

to High Deprivation

Comparisons between Sucrose Concentration by Test and Retest Trial Block
(MSe = 0.204)

Block	1	2	3	4
8% vs. 20%	-	-	-	-

Comparisons between Test & Retest Trial Blocks within each Sucrose Concentration Group
(MSe = 0.217)

	Block	1	4	2	3
8%	1		-	-	-
	4			-	-
	2				-
20%	Block	4	1	3	2
	4		-	-	-
	1			-	-
	3				-

$^{**}p < .01$, $^{*}p < .05$, - NS

For purposes of completeness both types of analysis (1 - analysis by separate phase and 2 - analysis across phases) were carried out and will be reported in order.

According to the first analysis, during the test phase (Table 7c, p. 70) only moderate deprivation groups were selecting the sucrose position significantly above chance on both blocks of trials ($p < .01$). For high deprivation animals, only the 20% group was significantly above chance and only on block 1 ($p < .05$). During the retest phase (Table 8c, p. 71) moderate deprivation groups (now shifted to high deprivation) chose sucrose significantly more often than chance on both retest trial blocks ($p < .01$). For high deprivation animals (shifted to moderate) above chance selection of sucrose on both retest blocks for 20% groups ($p < .01$) and on block 2 ($p < .05$) for 8% groups was found.

According to the second analysis, moderate deprivation animals shifted to high deprivation (Table 10c, p. 73) selected sucrose more often than chance on both blocks of both test and retest phases ($p < .01$). For high deprivation groups shifted to moderate deprivation (Table 9c, p. 72) only the 20% sucrose groups were significantly above chance and only on block 2 of the retest phase ($p < .05$).

The analysis of choice data for the highly deprived groups yielded different results depending on which

Table 7c

Individual Comparisons (Newman-Keuls Procedure) between Obtained Number of Sucrose Choices and Expected by Chance (50% - 3 choices/6 free choice trials) TEST PHASE

(MSe = 0.073)

Blocks	High 8%	Mod 8%	High 20%	Mod 20%
1	-	**	*	**
2	-	**	-	**

**p < .01, *p < .05, - NS

Table 8c

Individual Comparisons (Newman-Keuls Procedure) between Obtained Number of Sucrose Choices and Expected by Chance (50% - 3 choices/6 free choice trials) RETEST PHASE

(MSe = 0.036)

Blocks	High 8%	Mod 8%	High 20%	Mod 20%
1	-	**	**	**
2	*	**	**	**

$^{**}p < .01$, $^{*}p < .05$, - NS

Table 9c

Individual Comparisons (Newman-Keuls Procedure) between Obtained Number of Sucrose Choices and Expected by Chance for High Deprivation Shifted to Moderate Deprivation

(MSe = 0.295)		
Blocks	8%	20%
1	-	-
2	-	-
3	-	-
4	-	**

$^{**}p < .01$, $^{*}p < .05$, - NS

Table 10c

Individual Comparisons (Newman-Keuls Procedure) between Obtained Number of Sucrose Choices and Expected by Chance for Moderate Deprivation Shifted to High Deprivation

(MSe = 0.217)		
Blocks	8%	20%
1	**	**
2	**	**
3	**	**
4	**	**

**p < .01, *p < .05, - NS

statistical test was used and thus there was a problem with regard to interpretation. In the first analysis the power of the Newman-Keuls procedure was increased since values generated from the separate test and retest ANOVA's involved an n = 24 whereas in the second case fewer subjects were included (n = 12) thus reducing the power of the statistical test. Since it appeared that the effects involved were marginal it was decided to accept the analysis of the more conservative test and this is reflected in the interpretation of the data.

In summary, examination of choice behaviour revealed that

(1) mode of training had no effect upon sucrose preference

(2) moderately deprived animals developed a definite preference for sucrose although such a preference developed earlier in animals running to a 20% concentration as compared to an 8% solution.

(3) sucrose preference was maintained in moderate deprivation animals even when such animals were shifted to high deprivation

(4) high deprivation animals showed no clear preference for sucrose during either the training or testing phase

(5) during retesting high deprivation animals shifted to moderate deprivation showed no preference for sucrose except for groups running to a 20% solution who demonstrated a preference for sucrose on trial block 2 of the retest phase.

CHAPTER IV

CONCLUSIONS AND DISCUSSION

The results reported above appear to support the prediction that moderately water deprived animals, regardless of training mode, show a preference for sucrose solutions over water. During the training phase, alternation groups running for both 8% and 20% sucrose solutions selected the sucrose incentive position on free choice trials significantly more often than would be expected by chance, although the development of such a preference was somewhat slower for groups running to 8% sucrose than for groups running to 20% sucrose. Similarly, during the test phase, both alternation and sequential groups selected sucrose significantly above chance. Furthermore, all moderately deprived groups developed significantly faster running speeds to the sucrose position as compared to the water position, although again, differential running speeds appeared later in the training phase for 8% groups than for 20% groups. Differences in running speeds between incentive positions were maintained for all moderate groups during the test phase.

For highly water deprived animals, the prediction that sequential rather than alternation training would produce a preference for sucrose was not supported. During the training phase, alternation groups did not chose the sucrose position above chance on free choice trials. During testing, neither alternation nor sequential animals selected sucrose at a level significantly above chance responding. Furthermore, except for some initial differences, running speeds to both incentive positions were not significantly different during either the training or testing phases. The results for the highly water deprived animals are consistent with the findings of Beck and Bidwell (1974). They have suggested that for highly water deprived animals either preferences do not exist or that the test procedure is insensitive for uncovering differences in incentive motivation. The latter explanation is in accord with the approach-arousal hypothesis (Beck et al, 1972) since presumably the incentive values of water and sucrose are equalized or nearly equalized in the highly water deprived rat.

The question remains however, as to whether or not highly water deprived rats actually learn the location of the different incentives using a free choice procedure in a two choice apparatus. If highly deprived animals failed to acquire incentive-position associations then we cannot conclude that such animals have no incentive preference. If, however, highly deprived animals learned the position of each incentive, then they apparently preferred neither. The findings for the retest conditions in which animals' deprivation levels were switched have a possible bearing on this question. Animals that were trained on 8% sucrose continued to display no preferences on their retest (moderate deprivation) sessions. However, 20% sucrose animals developed a rapid preference for sucrose, as measured by running speeds and choices, by the second block of trials. Therefore, highly deprived animals who received 20% sucrose may have acquired incentive-position associations during original training. It is possible that residual high deprivation effects persisted over the 72 hour rest period into the first block of the retest trial to obscure such preferences. It is also possible, however, that these animals were merely able to acquire such necessary information about incentive position during the retest period. It should be noted that moderately deprived animals took longer, 3 trial blocks, to develop similar incentive approach differences during training. The relatively rapid acquisition of incentive locations of the 20% high-moderate group might be a function of generalized experience with the apparatus and experimental situation. In view of this possibility, comparisons with the acquisition rate of initially naive moderately deprived animals is questionable. A more appropriate comparison would be with an additional control group which had experienced identical training and testing procedures with a constant incentive at each position. If some general transfer of experience occurs then presumably such a control should acquire an association between incentive value and location during the retest phase with fixed incentive as rapidly as the experimental group of the present study. Therefore, the question remains as to whether highly water deprived animals were able to acquire incentive-position associations.

If it is assumed that highly water deprived rats do not prefer sucrose, then moderately deprived subjects when shifted to high deprivation should reduce preferential responding. This was clearly not the case for the moderate deprivation groups of this study. Such groups when shifted to high deprivation continued to select the sucrose position at a rate significantly above chance and, furthermore, maintained faster running to sucrose than to water. At the same time however, it should be noted that speed to water during the retest phase increased dramatically over speeds obtained during testing. Therefore, additional retesting trials might have reduced the speed differential to insignificance. This possibility aside, it appears from the present study that if sucrose preferences develop in moderately deprived rats, such preferences will be maintained, at least initially following a shift to high water deprivation.

Since it is not clear from the results of this study whether highly deprived subjects acquired an association between incentive position and value, the question of sucrose preferences in highly deprived rats remains unanswered. While it does not appear that mode of training is a relevant variable, the fact that Cohen and Oostendorp obtained sucrose preferences in highly water deprived rats while Beck and Bidwell (1974) and the present study did not, points to another difference. Recall that Cohen and Oostendorp used 12 trials per day whereas both Beck and Bidwell and the present study employed only 6 trials per session. It is possible that 6 trials per session may not provide sufficient daily experience to establish an association between incentive position and value in the highly water deprived rat. It is suggested that studies be run to vary the daily and total amount of experience to investigate this factor.

In any case, in order to determine sucrose preference we require a procedure which insures that the appropriate association between incentive value and location is acquired. One possibility is to run highly deprived subjects in an alternation sequence with the additional provision that a marker cue be used to signal the location of the sucrose incentive. This procedure, coupled with extended training should insure the acquisition of the appropriate association and thus preferences, if such exist, should develop over the course of training. Again, choice behaviour on free choice trials and running speed on all trials could be used as measures of sucrose preference.

It remains to be explained why sucrose concentration effects in the form of interactions with other variables were found in this study. Moderately deprived 20% groups demonstrated preference for sucrose solutions on both choice and running speed measures earlier in the training phase than 8% moderate groups. Similarly, highly deprived groups when shifted to moderate deprivation demonstrated a preference for 20% sucrose on block 2 of retesting in contrast to 8% groups who responded equally to sucrose or water. A possible explanation, albeit highly speculative, might be derived from Grice's (1971) utilization of signal detection theory to explain drive-incentive interactions. Beck and Austin (1973) who used this model to account for the interaction between hunger and incentive, have suggested that water deprivation serves to decrease sensitivity to liquid incentive differences. If this is so, then the ratio of signal (sucrose) to noise (water) should be greater for 20% sucrose solutions than for 8% concentrations. Moderately water deprived animals, whose sensitivity to liquid incentive differences should be reduced by 18 hours of water deprivation, may well detect the higher signal-noise ratio of a 20% concentration as compared to water more rapidly than an 8% concentration and hence develop associations with location more easily. This might also explain why highly deprived animals, whose sensitivity to liquid incentive differences is much reduced, might have difficulty in acquiring incentive-position associations. Clearly additional experimentation is required to determine if signal detection theory is a useful vehicle for resolving incentive-deprivation interactions.

While the purpose of this experiment was to resolve differences in experimental outcomes and as such does not test a specific theory, it might be instructive to evaluate the present results in terms of theories designed to explain deprivation-incentive interactions. As has been mentioned above, the results do not contradict the approach-arousal hypothesis (Beck et al, 1972). The incentive value of water is increased under conditions of high water deprivation to a value equal to or nearly equal to that of sucrose solutions, and thus highly water deprived rats will demonstrate no preference for either incentive. For moderately deprived rats the incentive value of water is below that of sucrose and hence a sucrose preference is demonstrated.

According to Young (1955, 1961), animals prefer sweet substances and the sweeter the taste, the more the animal is aroused and the more vigorous the consumatory response. Thus, higher concentrations of sucrose should generate more vigorous responding than lower concentrations or water. This notion appears to receive some support from the current study in that moderately deprived animals ran faster to sucrose than water, and, further, 20% groups showed preferential responding earlier than 8% groups. Since according to Young, drive level serves to increase the incentive value of goal objects, he would predict sucrose preferences in highly deprived rats. In fact, responding should be more vigorous for highly deprived than moderately deprived animals. This result was not of course, obtained in this study; that is, high deprivation animals responded nonpreferentially to sucrose solutions and water. If we assume that the rats knew the location of the differing incentives, then we would have to conclude that 'hedonic' theory does not appear to accurately describe the relationship between high water deprivation and sucrose incentive value.

Cohen and Tokieda (1972) have suggested that the amount of hydration that occurs during the test session is the critical variable in determining sucrose preferences. They argue that a water deprived rat prefers water to sucrose in a one lick test because of the animals dehydrated condition and presumably the sucrose solution would dehydrate the animals further. This explanation is probably inappropriate since it is difficult to see how sucrose solutions contribute to dehydration. Beck (1967) and Jacobs (1964) failed to obtain such dehydration with limited stomach or brain infusion techniques. Such a position is more useful in explaining similar effects with saline solutions since ingestion of saline by a thirsty animal would cause further dehydration (Shuford, 1956).

On the basis of Mook's (1974) informational hypothesis, one would predict that highly water deprived rats would show a sucrose preference. Mook suggests that sweetness acts as a cue indicating food value to the animal. Morrison (1968) has suggested that the energy cost of drinking a liquid diet is much less than chewing solid food. If indeed the thirsty rat is also hungry, then one would predict a sucrose preference, since drinking would be the most efficient way of obtaining both caloric and water requirements. In the present study, however, animals were placed in their home cages during the 10 to 12 minute intertrial interval. At this time Purina Lab Chow was available in the food hopper. In addition it appears as though the animals were hungry since it was noted that as each daily training session progressed the rats engaged in more eating behaviour on each successive intertrial interval.'

In summary, regardless of what theoretical notion is examined it is critical for a proper test that the procedure be such as to insure acquisition of an incentive-position association. While the present study has eliminated certain variables as necessary, it is not entirely clear that the procedure allowed for the acquisition of such associations in highly water deprived subjects.

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APPENDIX A

Mean Running Speed to Incentive Positions by Subject by Experimental Group for each Two Day Trial Block (6 trials) Training Phase

Group - Hi-Alt 0% vs. 8%

Subject #	Blocks 1		2		3		4		5	
	0%	8%	0%	8%	0%	8%	0%	8%	0%	8%
1	0.89	0.24	1.07	0.35	1.01	0.36	0.86	0.66	0.94	0.42
5	0.57	0.31	0.35	0.16	0.47	0.20	0.40	0.32	0.50	0.46
9	0.43	0.42	0.37	0.32	0.43	0.48	0.53	0.73	0.72	0.67
13	0.10	0.69	0.32	0.63	0.63	0.62	0.56	0.51	0.75	0.57
49	0.46	0.56	0.54	0.36	0.70	0.37	0.78	0.47	0.72	0.49
57	0.70	0.44	0.95	0.27	0.96	0.42	1.03	0.45	0.90	0.59
51	0.89	0.44	0.63	0.55	0.35	0.73	0.57	0.99	0.69	1.04
59	0.56	1.00	0.69	1.04	0.70	1.18	0.81	0.92	0.84	0.88
65	0.94	0.46	0.52	0.41	0.52	0.45	0.62	0.32	0.48	0.54
73	0.56	0.69	0.75	0.51	0.78	0.67	0.65	0.63	0.71	0.88
67	0.85	0.37	1.10	0.74	0.47	0.77	0.77	1.14	1.06	0.90

APPENDIX A (Continued)

<u>Group - Hi - Alt 0% vs. 8%</u>

Subject #	Blocks 1		2		3		4		5	
	0%	8%	0%	8%	0%	8%	0%	8%	0%	8%
75	0.50	.089	0.53	0.45	0.49	0.91	0.50	0.77	0.69	1.03

<u>Group - Hi-Seq 0% vs. 8%</u>

Subject #	Blocks 1		2		3		4		5	
	0%	8%	0%	8%	0%	8%	0%	8%	0%	8%
2	0.26	0.50	0.38	0.50	0.39	0.78	0.40	0.82	0.53	0.67
8	0.62	0.18	0.66	0.23	0.62	0.24	0.87	0.31	0.83	0.39
10	0.51	0.26	0.66	0.32	0.74	0.42	0.44	0.52	0.45	0.50
16	0.41	0.24	0.58	0.25	0.61	0.42	0.60	0.63	0.45	0.76
50	0.29	0.43	0.36	0.52	0.38	0.60	0.45	0.68	0.51	0.56
58	0.75	0.32	0.77	0.37	0.76	0.35	0.79	0.43	0.71	0.39
56	0.53	0.40	0.66	0.49	0.75	0.68	0.84	0.74	0.55	0.81
64	0.40	0.78	0.50	0.76	0.96	0.52	0.62	0.99	0.51	0.92
66	0.59	0.39	0.42	0.37	0.32	0.47	0.52	0.51	0.36	0.63
74	0.30	0.44	0.33	0.49	0.52	0.51	0.50	0.57	0.52	0.81

APPENDIX A (Continued)

Group - Hi-Seq 0% vs. 8%

Subject #	Blocks 1		2		3		4		5	
	0%	8%	0%	8%	0%	8%	0%	8%	0%	8%
72	0.94	0.38	1.12	0.49	0.63	0.79	0.35	0.67	0.69	0.79
80	0.43	0.67	0.53	0.82	0.72	0.70	0.42	0.34	0.51	0.62

Group - Hi-Alt 0% vs. 20%

Subject #	1		2		3		4		5	
	0%	20%	0%	20%	0%	20%	0%	20%	0%	20%
17	0.65	0.45	0.79	0.48	0.72	0.45	0.50	0.71	0.63	0.81
21	0.52	0.50	0.56	0.96	0.64	1.01	0.73	0.99	0.92	0.94
23	0.22	0.35	0.16	0.31	0.21	0.50	0.39	0.45	0.47	0.52
25	0.35	0.59	0.34	0.87	0.39	1.00	0.41	0.87	0.36	0.89
29	0.27	0.38	0.63	0.35	0.45	0.48	0.70	0.46	0.68	0.57
33	0.61	0.81	0.54	0.95	0.70	0.94	0.76	0.89	0.89	0.96
39	0.48	0.43	0.86	0.51	0.89	0.68	0.88	0.65	0.86	0.76
47	0.38	1.02	0.47	1.18	0.55	1.08	0.56	1.05	0.43	0.92
81	0.54	0.59	0.61	0.82	0.61	0.78	0.66	0.80	0.82	1.05

APPENDIX A (Continued)

Group - Hi-Alt 0% vs. 20%

Subject #	Blocks 1		2		3		4		5	
	0%	20%	0%	20%	0%	20%	0%	20%	0%	20%
89	0.52	1.09	0.62	0.98	0.73	0.78	0.95	0.90	0.83	0.99
83	0.60	1.07	0.93	0.37	1.16	0.30	1.01	0.36	1.19	0.38
91	0.61	0.44	0.79	0.68	0.65	0.67	0.75	0.66	0.75	0.69

Group - Hi-Seq 0% vs. 20%

18	0.34	0.79	0.42	0.55	0.39	0.84	0.44	0.74	0.68	0.63
26	0.36	0.57	0.46	0.45	0.75	0.37	0.80	0.36	0.93	0.44
32	0.53	1.02	0.70	1.08	0.81	0.63	0.63	0.65	0.62	0.64
48	0.37	0.53	0.29	0.37	0.47	0.65	0.47	0.32	0.74	0.51
40	0.42	0.94	0.57	0.70	0.57	0.90	0.64	0.94	0.60	0.83
38	0.84	0.44	0.96	0.59	0.96	0.78	0.68	0.81	0.76	0.78
44	0.71	0.44	0.67	0.55	0.44	0.68	0.53	0.62	0.50	0.84
46	0.94	0.72	0.60	0.79	0.60	1.11	0.74	1.05	0.59	0.89
82	0.47	0.93	0.48	0.86	0.55	0.65	0.49	0.68	0.61	0.85

APPENDIX A (Continued)

Group - Hi-Seq 0% vs. 20%

Subject #	Blocks									
	1		2		3		4		5	
	0%	20%	0%	20%	0%	20%	0%	20%	0%	20%
90	0.54	0.72	0.56	1.01	0.76	0.50	0.78	0.76	0.82	0.68
88	0.38	0.94	0.62	0.77	0.53	0.98	0.66	0.67	0.64	0.93
96	0.53	0.88	0.44	0.87	0.58	0.72	0.71	0.90	0.73	0.74

Group - Mod-Alt 0% vs. 8%

	0%	8%	0%	8%	0%	8%	0%	8%	0%	8%
3	0.42	0.75	0.48	0.76	0.43	0.89	0.45	0.84	0.49	0.89
7	0.46	0.73	0.59	0.67	0.42	0.43	0.63	0.51	0.72	0.76
11	0.45	0.38	0.70	0.56	0.61	0.42	0.70	0.34	0.32	0.54
15	0.93	0.40	0.37	0.52	0.53	0.54	0.47	0.63	0.51	0.96
53	0.21	0.20	0.35	0.30	0.31	0.52	0.27	0.75	0.38	1.06
55	0.81	0.49	0.77	0.42	0.66	0.37	0.60	0.49	0.39	0.54
61	0.44	0.60	0.44	0.78	0.59	0.90	0.57	0.63	0.52	0.77
63	0.20	0.61	0.28	0.47	0.63	0.76	0.38	0.66	0.43	0.78

APPENDIX A (Continued)

Subject #	Blocks									
	1		2		3		4		5	
	0%	8%	0%	8%	0%	8%	0%	8%	0%	8%
Group - Mod-Alt 0% vs. 8%										
69	0.85	0.59	1.04	0.66	0.80	0.90	0.59	0.85	0.54	0.82
77	0.94	0.46	1.04	0.67	1.14	0.63	0.77	0.64	0.35	1.12
71	0.21	0.28	0.41	0.60	0.44	0.43	0.61	0.52	0.59	0.65
79	0.42	0.55	1.02	0.49	1.22	0.28	0.63	0.37	1.04	0.59
Group - Mod-Seq 0% vs. 8%										
4	0.76	0.37	0.80	0.31	0.40	0.34	0.34	0.41	0.38	0.51
6	0.70	0.27	0.56	0.26	0.42	0.25	0.27	0.32	0.38	0.44
12	0.28	0.45	0.31	0.48	0.36	0.60	0.40	0.60	0.45	0.56
14	0.58	0.32	0.92	0.39	0.61	0.54	1.03	0.45	0.39	0.77
52	0.34	0.31	0.21	0.36	0.27	0.54	0.33	0.44	0.42	0.52
54	0.26	0.73	0.55	0.88	0.67	0.47	0.43	0.39	0.43	0.58
60	0.44	0.49	0.73	0.55	0.34	0.76	0.53	0.77	0.59	0.64
62	0.33	0.59	0.20	0.30	0.45	0.62	0.24	0.48	0.20	0.66

APPENDIX A (Continued)

Group - Mod-Seq 0% vs. 8%

Subject #	Blocks									
	1		2		3		4		5	
	0%	8%	0%	8%	0%	8%	0%	8%	0%	8%
68	1.00	0.49	1.15	0.41	0.92	0.57	0.53	0.89	0.64	0.83
76	1.09	0.47	0.79	0.50	0.34	0.65	0.34	0.63	0.58	1.10
70	0.80	0.45	0.85	0.51	0.73	0.44	0.56	0.39	0.45	0.59
78	0.41	0.66	0.60	0.91	0.53	1.06	0.64	0.84	0.70	1.00

Group - Mod-Alt 0% vs. 20%

	0%	20%	0%	20%	0%	20%	0%	20%	0%	20%
19	0.25	0.38	0.23	0.23	0.29	0.39	0.33	0.52	0.39	0.54
27	0.31	0.38	0.35	0.37	0.34	0.50	0.37	0.36	0.25	0.44
31	0.27	0.59	0.23	0.40	0.45	0.21	0.28	0.63	0.40	0.79
35	0.36	0.54	0.78	0.46	0.57	0.85	0.57	0.97	0.56	1.08
41	0.70	0.27	0.87	0.21	0.78	0.18	0.64	0.30	0.64	0.43
37	0.44	0.85	0.40	0.67	0.47	1.03	0.20	0.76	0.14	0.95
43	0.87	0.55	0.63	0.61	0.54	0.87	0.04	0.08	0.15	0.26

APPENDIX A (Continued)

Group - Mod-Alt 0% vs. 20%

Subject #	Blocks 1 0%	1 20%	2 0%	2 20%	3 0%	3 20%	4 0%	4 20%	5 0%	5 20%
45	1.05	0.66	0.98	0.63	0.26	1.05	0.60	1.35	0.57	1.32
85	0.40	0.74	0.53	0.78	0.31	0.84	0.52	0.73	0.57	0.84
93	0.58	1.05	0.61	1.02	0.80	0.88	0.70	1.01	1.07	1.00
87	0.12	0.06	0.56	0.24	0.17	0.54	0.26	0.49	0.31	0.50
95	0.50	0.54	0.36	0.90	0.34	0.95	0.51	1.07	0.37	1.20

Group - Mod-Seq 0% vs. 20%

Subject #	Blocks 1 0%	1 20%	2 0%	2 20%	3 0%	3 20%	4 0%	4 20%	5 0%	5 20%
20	0.42	0.27	0.60	0.29	0.32	0.18	0.58	0.28	0.31	0.43
22	0.12	0.31	0.10	0.20	0.22	0.40	0.36	0.55	0.44	0.70
28	0.58	0.31	0.73	0.42	0.33	0.45	0.37	0.65	0.40	0.72
30	0.37	0.22	0.28	0.28	0.13	0.41	0.38	0.67	0.38	0.69
24	0.77	0.47	0.78	0.49	0.39	0.65	0.27	0.78	0.30	0.89
34	0.52	0.24	0.46	0.36	0.39	0.46	0.33	0.61	0.53	0.77
36	1.44	0.62	0.79	0.93	1.72	0.74	1.08	.137	0.60	1.22

APPENDIX A (Continued)

Group - Mod-Seq 0% vs. 20%

Subject #	Blocks 1		2		3		4		5	
	0%	20%	0%	20%	0%	20%	0%	20%	0%	20%
42	0.14	0.40	0.18	0.63	0.23	0.72	0.18	0.76	0.35	0.65
84	0.36	0.42	0.42	0.65	0.45	0.57	0.48	0.64	0.29	0.38
92	1.19	0.28	1.25	0.26	1.11	0.28	0.86	0.74	0.24	1.49
86	1.19	0.47	0.99	0.49	0.71	0.34	0.18	0.58	0.31	0.97
94	0.31	0.91	0.37	0.97	0.46	1.10	0.50	0.97	0.16	1.18

APPENDIX B

Mean Running Speed to Incentive Positions by Subject by Experimental Group for each Two Day Trial Block (6 trials) Test and Retest Phase

<u>Group - Hi-Alt 0% vs. 8%</u>

Subject #	Test				Retest			
Blocks	1		2		1		2	
	0%	8%	0%	8%	0%	8%	0%	8%
1	0.94	0.42	0.88	0.29	0.80	0.44	0.61	0.44
5	0.28	0.52	0.34	0.45	0.27	0.15	0.42	0.35
9	0.66	0.46	0.60	0.57	0.49	0.54	0.57	0.62
13	1.13	0.77	0.87	0.73	0.52	0.88	0.69	0.72
49	0.82	0.42	0.93	0.54	0.81	0.35	0.47	0.21
57	0.57	0.89	0.80	0.70	0.29	0.72	0.20	0.67
51	0.72	1.12	0.80	1.11	0.75	1.01	0.75	0.93
59	0.87	0.92	0.88	1.03	0.82	0.99	0.85	0.66
65	0.63	0.51	0.76	0.66	0.42	0.40	0.33	0.53
73	0.51	0.64	0.65	0.90	0.52	0.98	0.71	0.93
67	0.76	0.99	0.70	1.09	0.72	0.67	0.79	1.00
75	0.88	1.12	0.90	1.23	0.86	0.96	0.96	1.21

APPENDIX B (Continued)

Group - Hi-Seq 0% vs. 8%

Subject #	Test				Retest			
Blocks	1		2		1		2	
	0%	8%	0%	8%	0%	8%	0%	8%
2	0.57	0.72	0.60	0.69	0.46	0.49	0.30	0.53
8	0.59	0.46	0.85	0.77	0.80	0.55	0.14	0.63
10	0.58	0.73	0.51	0.80	0.69	0.72	0.68	0.68
16	0.57	0.77	0.51	0.79	0.55	0.42	0.45	0.60
50	0.54	0.54	0.71	0.65	0.38	0.30	0.41	0.46
58	0.82	0.47	0.85	0.39	0.87	0.41	0.72	0.36
56	0.74	0.77	0.66	0.88	0.55	0.70	0.50	0.45
64	0.39	0.68	0.70	0.31	0.50	0.35	0.81	0.28
66	0.59	0.56	0.58	0.65	0.46	0.57	0.35	0.30
74	0.76	0.72	0.70	0.90	0.48	0.80	0.43	0.66
72	0.78	0.92	1.01	0.64	0.63	0.73	0.60	0.56
80	0.67	0.53	0.61	0.48	0.73	0.41	0.64	0.47

APPENDIX B (Continued)

Group - Hi-Alt 0% vs. 20%

Subject #	Test				Retest			
Blocks	1		2		1		2	
	0%	20%	0%	20%	0%	20%	0%	20%
17	0.58	0.90	0.78	0.97	0.88	0.80	0.71	1.02
21	0.78	0.82	0.94	1.06	0.95	1.10	0.96	1.20
23	0.64	0.50	0.50	0.45	0.65	0.48	0.57	0.57
25	0.45	0.95	0.51	0.95	0.49	1.06	0.44	1.04
29	0.54	0.78	0.71	0.77	0.76	0.77	0.75	0.72
33	0.91	0.87	0.81	0.46	0.60	0.77	0.77	0.93
39	0.94	1.05	1.05	0.89	0.62	0.78	0.56	0.97
47	0.32	1.03	0.36	1.08	0.33	1.05	0.29	1.07
81	0.75	0.91	0.67	0.91	0.70	0.85	0.79	0.95
89	0.99	0.84	1.04	1.14	1.12	1.10	0.97	1.04
83	0.94	0.36	1.14	0.50	0.94	0.62	1.14	0.92
91	0.67	0.55	0.79	0.85	0.44	0.38	0.50	0.44

APPENDIX B (Continued)

Group - Hi-Seq 0% vs. 20%

Subject #	Test				Retest			
Blocks	1		2		1		2	
	0%	20%	0%	20%	0%	20%	0%	20%
18	0.82	0.31	0.80	0.29	0.71	0.37	0.48	0.77
26	0.80	0.47	1.16	0.73	0.97	0.68	1.21	0.64
32	0.84	0.90	0.90	0.79	0.96	0.99	1.02	0.62
48	0.71	0.69	0.66	0.74	0.54	0.31	0.42	0.38
40	0.65	0.82	0.88	0.71	0.49	0.58	0.54	0.73
38	0.85	0.66	0.95	0.79	0.77	0.68	0.77	0.95
44	0.61	0.86	0.66	0.85	0.30	0.23	0.33	0.49
46	0.74	0.99	0.65	1.04	0.79	0.96	0.76	1.01
82	0.70	0.78	0.85	0.87	0.83	0.77	0.63	0.82
90	1.00	0.62	0.96	0.82	1.11	0.76	0.72	0.82
88	0.71	0.96	0.74	0.80	0.67	0.58	0.69	0.78
96	0.61	0.77	0.67	0.90	0.48	0.86	0.66	0.91

APPENDIX B (Continued)

Group - Mod-Alt 0% vs. 8%

Subject #	Test				Retest			
Blocks	1		2		1		2	
	0%	8%	0%	8%	0%	8%	0%	8%
3	0.30	0.86	0.48	0.84	0.73	0.85	0.76	1.01
7	0.55	0.74	0.77	0.67	0.84	0.78	0.84	0.99
11	0.60	0.69	0.59	0.73	0.69	0.83	0.55	0.78
15	0.58	0.96	0.60	1.08	0.85	1.12	1.05	1.14
53	0.44	0.67	0.23	0.76	0.36	0.83	0.71	0.84
55	0.46	0.50	0.38	0.70	0.37	0.58	0.36	0.99
61	0.53	1.13	0.58	0.98	0.80	1.27	0.89	1.23
63	0.35	0.93	0.44	0.81	0.89	0.56	0.82	0.35
69	0.51	1.11	0.71	1.13	0.88	0.82	1.04	1.13
77	0.51	1.06	0.74	0.96	0.86	0.93	0.93	0.84
71	0.58	0.84	0.66	0.88	0.67	0.86	0.95	1.00
79	1.17	0.53	0.95	0.57	0.50	0.57	0.31	0.58

APPENDIX B (Continued)

Group - Mod-Seq 0% vs. 8%

Subject #	Test				Retest			
Blocks	1		2		1		2	
	0%	8%	0%	8%	0%	8%	0%	8%
4	0.32	0.77	0.21	0.89	0.53	0.82	0.82	0.89
6	0.24	0.34	0.31	0.45	0.55	0.58	0.62	0.75
12	0.55	0.67	0.46	0.71	0.44	0.71	0.62	0.94
14	0.48	0.66	0.50	0.61	0.58	0.50	0.73	0.68
52	0.63	0.40	0.20	0.50	0.49	0.51	0.55	0.50
54	0.63	0.67	0.46	0.84	0.39	0.82	0.55	0.98
60	0.59	0.68	0.70	0.81	0.75	0.78	0.75	0.73
62	0.17	0.63	0.30	0.81	0.56	0.93	0.66	0.78
68	0.64	1.21	0.66	1.12	0.78	1.13	0.85	0.95
76	0.92	1.04	0.78	1.04	0.82	1.18	0.90	1.11
70	0.42	0.66	0.63	0.79	0.59	0.68	0.70	0.67
78	0.64	1.15	0.56	1.21	0.92	1.06	1.08	1.11

APPENDIX B (Continued)

Group - Mod-Alt 0% vs. 20%

Subject #	Test				Retest			
Blocks	1		2		1		2	
	0%	20%	0%	20%	0%	20%	0%	20%
19	0.41	0.54	0.28	0.56	0.56	0.70	0.66	0.79
27	0.34	0.60	0.24	0.62	0.29	0.58	0.30	0.38
31	0.68	0.79	0.37	0.94	0.81	1.08	0.87	0.65
35	0.71	1.20	0.68	1.14	0.55	1.05	0.53	1.14
41	0.49	0.38	0.10	0.38	0.44	0.57	0.76	0.66
37	0.21	1.17	0.36	1.12	0.48	1.14	0.72	1.19
43	0.10	0.53	0.24	0.58	0.71	0.56	0.68	0.70
45	0.63	1.42	0.69	1.35	0.79	1.17	0.99	0.90
85	0.10	0.73	0.09	0.78	0.21	0.63	0.29	0.82
93	1.16	0.81	1.28	0.92	1.19	0.73	1.20	0.78
87	0.12	0.52	0.13	0.55	0.34	0.37	0.58	0.65
95	0.39	0.98	0.64	1.24	0.86	1.13	1.13	1.01

APPENDIX B (Continued)

Group - Mod-Seq 0% vs. 20%

Subject #	Test				Retest			
Blocks	1		2		1		2	
	0%	20%	0%	20%	0%	20%	0%	20%
20	0.22	0.60	0.21	0.48	0.56	0.67	0.60	0.60
22	0.47	0.49	0.45	0.59	0.64	0.83	0.77	0.92
28	0.30	0.43	0.38	0.84	0.58	0.84	0.45	0.70
30	0.48	0.56	0.37	0.74	0.86	0.81	0.91	0.81
24	0.17	0.80	0.26	1.00	0.38	0.91	0.57	0.99
34	0.67	0.87	0.72	0.84	0.68	0.81	0.89	0.97
36	1.12	1.21	1.35	1.24	0.90	0.99	0.53	1.24
42	0.25	0.82	0.27	0.79	0.47	0.72	0.81	0.85
84	0.13	0.33	0.31	0.37	0.48	0.59	0.64	0.56
92	0.53	1.33	0.71	1.34	0.88	1.20	1.10	1.04
86	0.54	1.03	0.25	0.90	0.50	0.72	0.89	0.82
94	0.27	1.26	0.25	1.37	0.27	1.29	0.38	1.25

APPENDIX C

Number of Choices to Sucrose Incentive Position by Subject for Training Testing and Retesting by Experimental Group

Group - Hi-Alt 0% vs. 8%		Train					Test		Retest	
Subject #	Block	1	2	3	4	5	1	2	1	2
1		0	0	0	1	0	0	0	1	2
5		0	0	0	1	0	2	3	1	2
49		2	2	0	0	0	0	0	0	0
51		0	3	5	6	6	6	6	5	5
65		1	1	2	0	3	0	4	5	6
67		0	0	3	3	3	4	5	4	4
9		2	3	5	2	5	3	4	4	4
13		5	4	5	3	2	0	2	4	5
57		2	0	0	0	4	4	2	6	6
59		6	6	6	5	5	6	6	3	6
73		2	0	0	2	3	6	6	3	6
75		6	3	6	6	6	6	6	6	6

APPENDIX C (Continued)

Group Hi-Seq 0% vs. 8%	Train					Test		Retest	
Subject #	Block 1	2	3	4	5	1	2	1	2
2						6	6	6	6
50						5	6	6	6
66						2	2	1	1
8						2	2	2	6
56						2	4	5	2
72						3	1	3	4
10						6	6	5	5
58						0	0	0	0
74						4	3	3	5
16						6	6	3	4
64						5	1	2	0
80						2	1	4	4
Group Hi-Alt 0% vs. 20%									
17	2	2	1	4	5	6	5	5	6
39	2	1	0	0	2	3	1	3	5
81	3	5	5	6	6	5	6	4	6

APPENDIX C (Continued)

Group Hi-Alt 0% vs. 20%	Train					Test		Retest	
Subject # Block	1	2	3	4	5	1	2	1	2
21	3	6	6	6	6	4	6	5	6
23	5	6	6	6	6	4	4	3	6
83	6	1	0	0	0	0	0	2	4
25	4	6	6	6	6	6	6	6	6
47	6	6	6	6	6	6	5	6	6
89	6	6	4	3	5	6	4	5	5
29	4	1	3	1	1	3	6	4	5
33	6	6	6	5	4	5	1	3	5
91	1	2	4	2	2	0	3	2	3
Group Hi-Seq 0% vs. 20%									
18						2	0	1	5
40						6	3	5	6
82						6	6	5	6
32						3	6	5	6
44						4	6	5	6

APPENDIX C (Continued)

Group Hi-Seq 0% vs. 20%	Train					Test		Retest	
Subject # Block	1	2	3	4	5	1	2	1	2
88						4	4	4	3
26						2	2	3	4
48						4	5	5	5
90						3	1	4	4
38						2	2	3	6
46						6	6	6	6
96						6	6	4	6
Group Mod-Alt 0% vs. 8%									
3	6	6	6	6	6	6	6	6	6
53	1	1	3	3	4	6	6	6	2
69	0	0	1	3	4	4	5	6	6
7	6	6	5	5	6	6	6	6	6
55	0	1	0	0	4	3	4	6	6
71	4	5	4	4	6	6	6	6	6
11	3	1	1	2	4	3	2	4	5

APPENDIX C (Continued)

Group Mod-Alt 0% vs. 8%		Train					Test		Retest	
Subject #	Block	1	2	3	4	5	1	2	1	2
61		6	6	6	6	6	6	6	6	6
77		0	2	0	2	4	3	4	5	3
15		0	4	4	6	6	6	6	6	6
63		6	6	6	6	6	6	6	3	3
79		3	1	1	0	0	3	1	3	5
Group Mod-Seq 0% vs. 8%										
70							3	5	3	4
54							6	6	6	6
4							6	6	6	6
68							6	6	6	5
52							3	6	4	4
6							5	6	6	6
14							5	6	5	5
60							3	6	5	3
76							5	5	6	5

APPENDIX C (Continued)

Group Mod-Seq 0% vs. 8%	Train					Test		Retest	
Subject # Block	1	2	3	4	5	1	2	1	2
12						6	5	6	6
62						6	6	6	6
78						4	4	5	6
Group Mod-Alt 0% vs. 20%									
19	3	4	5	6	6	6	6	6	6
35	4	0	6	6	6	6	6	6	6
85	6	6	6	5	6	5	6	6	6
31	6	6	3	3	4	3	6	5	6
43	0	1	4	2	5	6	6	4	4
87	1	3	4	6	6	6	6	5	5
27	3	4	4	6	6	6	6	6	6
41	0	0	0	0	0	2	5	4	3
93	6	6	6	6	6	4	4	3	3
37	6	6	6	6	6	6	6	6	6
45	0	0	4	6	6	6	6	6	4

APPENDIX C (Continued)

Group Mod-Alt. 0% vs. 20%		Train					Test		Retest	
Subject #	Block	1	2	3	4	5	1	2	1	2
95		5	6	6	6	6	6	6	5	4
Group Mod-Seq 0% vs. 20%										
22							6	6	6	5
24							6	6	6	6
84							6	6	6	5
20							6	4	6	5
36							4	4	5	6
86							4	6	6	5
30							5	6	4	3
34							6	6	6	6
92							6	6	6	4
28							4	5	6	5
42							5	5	5	6
94							6	6	6	6

VITA AUCTORIS

1941	Born in St. Catherines, Ontario to Lenard and Freda Fisk
1946-53	Educated in the St. Catherines Public School system.
1953-58	Attended Linwell High School, St. Catherines, Ontario and graduated with senior matriculation diploma
1965	Graduated with Bachelor of Arts (B. A.) in Psychology and English from the University of Western Ontario
1969	Graduated with Diploma in Business Administration from the University of Toronto
1975	Registered as full time graduate student at the University of Windsor